HEATHKIT® MANUAL

for the

HAND-HELD 2-METER TRANSCEIVER

Model VF-2031

595-2085-02



HEATH COMPANY • BENTON HARBOR, MICHIGAN

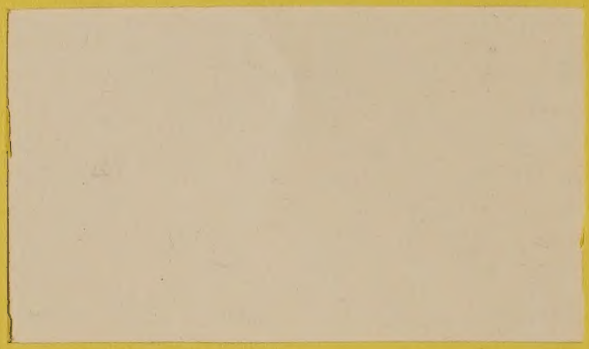
HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information (616) 982-3411
Credit (616) 982-3561
Replacement Parts (616) 982-3571

Technical Assistance Phone Numbers
8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only

R/C, Audio, and Electronic Organs (616) 982-3310
Amateur Radio (616) 982-3296
Test Equipment, Weather Instruments and Home Clocks (616) 982-3315
Television (616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive, Appliances and General Products (616) 982-3496
Computers (616) 982-3309



YOUR HEATHKIT 90 DAY LIMITED WARRANTY

If you are not satisfied with our service - warranty or otherwise - or with our products, write directly to our Director of Customer Services, Heath Company, Benton Harbor, Michigan 49022. He will make certain your problems receive immediate, personal attention.

Our attorney, who happens to be quite a kitbuilder himself, insists that we describe our warranty using all the necessary legal phrases in order to comply with the new warranty regulations. Fine. Here they are:

For a period of ninety (90) days after purchase, Heath Company will replace or repair free of charge any parts that are defective either in materials or workmanship. You can obtain parts directly from Heath Company by writing us at the address below or by telephoning us at (616) 982-3571. And we'll pay shipping charges to get those parts to you — anywhere in the world.

We warrant that during the first ninety (90) days after purchase, our products, when correctly assembled, calibrated, adjusted and used in accordance with our printed instructions, will meet published specifications.

If a defective part or error in design has caused your Heathkit product to malfunction during the warranty period through no fault of yours, we will service it free upon proof of purchase and delivery at your expense to the Heath factory, any Heathkit Electronic Center (units of Schlumberger Products Corporation), or any of our authorized overseas distributors.

You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

Our warranty does not cover and we are not responsible for damage caused by the use of corrosive solder, defective tools, incorrect assembly, misuse, fire, or by unauthorized modifications to or uses of our products for purposes other than as advertised. Our warranty does not include reimbursement for customer assembly or set-up time.

This warranty covers only Heathkit products and is not extended to allied equipment or components used in conjunction with our products. **We are not responsible for incidental or consequential damages.** Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

HEATH COMPANY
BENTON HARBOR, MI. 49022

Prices and specifications subject to change without notice.

SER# 02923

Heathkit® Manual

for the

HAND-HELD 2-METER TRANSCEIVER

Model VF-2031

595-2085-02

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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HEATHKIT

TABLE OF CONTENTS

INTRODUCTION 3

ASSEMBLY NOTES 4

BATTERY CHARGER
Parts List 7
Step-by-Step Assembly 8
Alternate Line Voltage Wiring 12
Final Charger Assembly 13

TRANSCEIVER
Parts List 14
Special Assembly Notes 18
Construction Hints 19
Step-by-Step Assembly 20
Circuit Board Assembly 20
Case Assembly 58
Case Front Assembly 68

INITIAL TESTS 70

ALIGNMENT
Alignment Preparation 72
Oscillator Chain Alignment 74
IF Alignment 75
Receiver Front End Alignment 76
Alignment Without Instruments 76
Alignment With Instruments 76
Transmitter Alignment 76
Initial Alignment 76
Final Alignment 77

FINAL ASSEMBLY 79

OPERATION 80
Battery Charging 81
Ordering Crystals 82
Available Accessories 83

IN CASE OF DIFFICULTY
Visual Tests 84
Troubleshooting Charts 86
Checking Transistors and Diodes 89

SPECIFICATIONS 90

CIRCUIT DESCRIPTION 92

CIRCUIT BOARD X-RAY
VIEWS (Illustration Booklet, Page 15)

SEMICONDUCTOR
IDENTIFICATION CHARTS 97

SCHEMATIC Fold-in

WARRANTY Inside front cover

CUSTOMER SERVICE Inside rear cover

INTRODUCTION

The Heathkit Model VF-2031 Hand-Held 2-Meter Transceiver is a 2-watt, solid-state, narrow-band FM Transceiver with provisions for eight simplex channels. Crystals are supplied for both +600 and −600 kHz transmitter offsets as well as a crystal for the popular 146.94 MHz channel.

Designed for portable use, this Transceiver contains ten rechargeable, AA size, nickel-cadmium batteries. A kit-built slide-in charger is supplied so you can easily charge the batteries.

You can completely align this Transceiver with only a VTVM or VOM, although alternate instrument alignment procedures are included in this Manual.

The following features are included in this high quality Transceiver:

- A dual-gate MOSFET receiver "front end" helps minimize front-end overloading and adjacent-channel interference.
- The same channel crystal is used for both receive and transmit.
- A 3-position offset switch allows you to select whether the transmitter operates 600 kHz above or below, as well as at, the receive frequency.
- A battery saver circuit helps conserve battery power when the receiver is squelched.
- 1 watt of audio output is available from the speaker.
- A BNC jack allows you to connect either the flexible antenna supplied or an optional external antenna.
- A phone jack is provided so you can use an external earphone (supplied) for private listening.

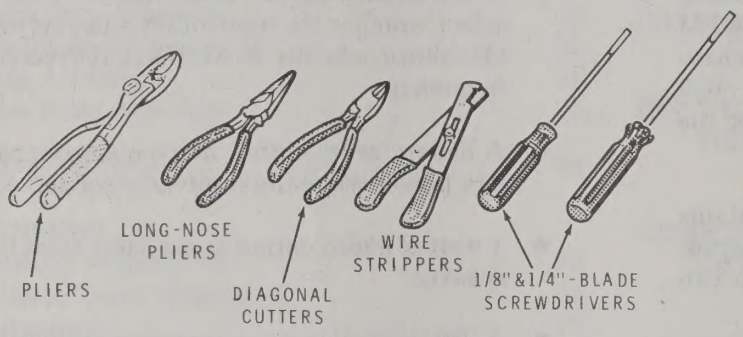
Both mobile and fixed station antennas for your Transceiver are available from the Heath Company. If you want more power, a 2-meter amplifier is also available. Other options for this Transceiver include a Push-To-Talk Microphone, an Audible/Subaudible Tone/Burst Accessory, an Auto Patch Encoder Accessory, and a Holster-Type Carrying Case.

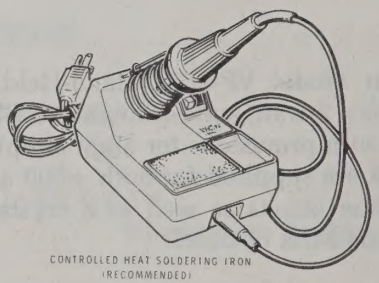
"Federal Communications Commission requirements prescribe maximum RF radiation from transceivers operating above 30 MHz. This transceiver will meet these requirements when constructed in strict accordance with the instructions in this Manual, using only components and materials supplied with the kit or the exact equivalent thereof. You will be instructed to sign and affix a label to the transceiver certifying that you have constructed this transceiver in accordance with the above mentioned instructions. In order to meet legal requirements, be certain to follow the instructions exactly as they are stated in this Manual."

ASSEMBLY NOTES

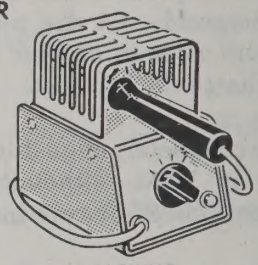
TOOLS

You will need these tools to assemble your kit.

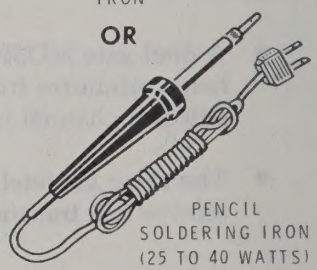




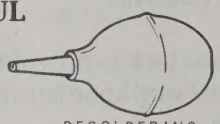
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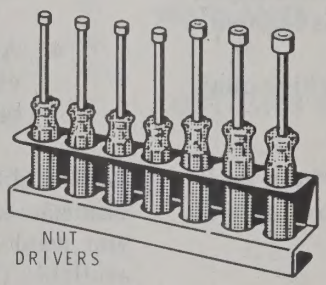


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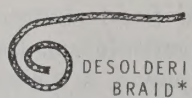


OTHER HELPFUL TOOLS









*TO REMOVE SOLDER FROM CIRCUIT CONNECTIONS.

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder a part or a group of parts only when you are instructed to do so.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

 — In the Parts List,

 — At the beginning of each step where a component is installed,

 — In some illustrations,

 — In the Schematic,

 — In the section at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

SAFETY WARNING: Avoid eye injury when you cut off excess lead lengths. Hold the leads so they cannot fly toward your eyes.

SOLDERING

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

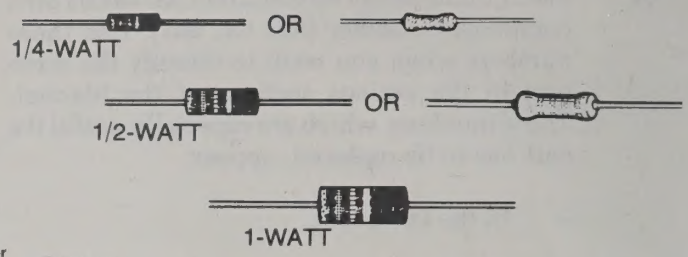
It is easy to make a good solder connection if you follow a few simple rules:

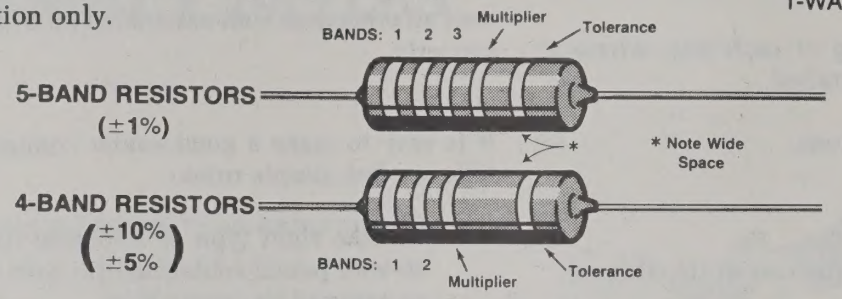
1. Use the right type of soldering iron. A 25 to 40-watt pencil soldering iron with a 1/8" chisel or pyramid tip works best.

2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

PARTS

Resistors will be called out by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). Certain types of resistors will have the value printed on the body, while others will be identified by a color code. The colors of the bands and the value will be given in the steps, therefore the following color code is given for information only.





Band 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

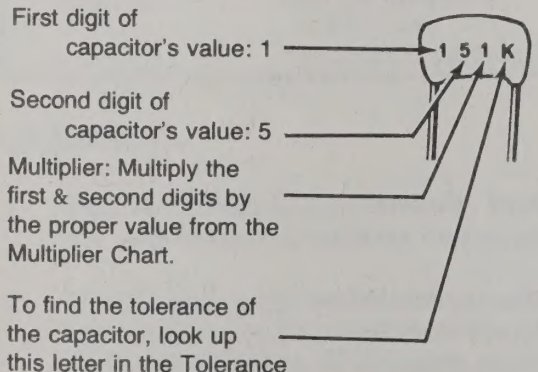
Band 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Band 3 (if used) 3rd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	±10%
Gold	± 5%
Brown	± 1%

Capacitors will be called out by their capacitance value in μF (microfarads) or pF (picofarads) and type: ceramic, Mylar*, electrolytic, etc. Some capacitors may have their value printed in the following manner:



EXAMPLES:

151K = 15 × 10 = 150 pF
759 = 75 ×0.1 = 7.5 pF

NOTE: The letter "R" may be used at times to signify a decimal point: as in: 2R2 = 2.2 (pF or μF).

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10 pF OR LESS	LETTER	OVER 10 pF
0	1	±0.1 pF	B	
1	10	±0.25 pF	C	
2	100	±0.5 pF	D	
3	1000	±1.0 pF	F	±1%
4	10,000	±2.0 pF	G	±2%
5	100,000.		H	±3%
			J	±5%
8	0.01		K	±10%
9	0.1		M	±20%

*DuPont Registered Trademark

BATTERY CHARGER

PARTS LIST

() Locate the container marked "Pack #1."

() Unpack these parts and check each part against the following list. The key numbers correspond to the numbers on the "Battery Charger Parts Pictorial" (Illustration Booklet, Page 1).

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Customer Service" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

ELECTRONIC COMPONENTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-470-12	1	47 Ω, 1/4-watt, 5% (yellow-violet-black) resistor	R301
A2	27-130	1	.22 μF Mylar capacitor	C301
A3	412-95	1	#3151 lamp	PL301

HARDWARE

NOTE: Hardware may be packed in more than one envelope. Open all of the hardware envelopes in this pack before you check the hardware against the following list.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
B1	250-321	6	4-40 × 1/8" screw
B2	250-312	2	4-40 × 3/4" screw
B3	252-711	8	4-40 twist-in nut
B4	252-15	1	4-40 nut
B5	255-150	1	Hex spacer

MISCELLANEOUS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
C1	252-73	1	Lamp retainer
C2	258-721	2	Contact clip
C3	413-10	1	Red lens

PARTS FROM THE MAIN PACK (parts still in the shipping carton)

Labels

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
D1	390-341	1	Heathkit label
D2	390-1221	1	Caution label
D3	390-1443	1	Top label*
D4	390-1444	1	Channel label*
D5	390-1517	1	Front label*
D6	390-1477	1	Bottom label*
D7	390-1484	1	FCC/alignment label*
D8	391-34	1	Blue and white label

*Set these labels aside for use during the assembly of the Transceiver.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Wire bundle				
	340-2	1′	Bare wire	
	343-12	1′	Shielded cable	
	344-172	3′6″	White solid wire	
	346-1	18″	Small sleeving	
	346-20	1′	Large (heat shrinkable) sleeving	
	347-55	3′	8-wire cable	
	348-2	6″	Magnet wire	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Other Parts				
E1	95-636-1	1	Charger case	
E2	75-768	1	Bottom cover	
E3	54-830	1	Power transformer	T301
	89-49	1	Line cord	
	489-1	1	Sheet of sandpaper	
	597-260	1	Parts Order Form	
		1	Manual (See Page 1 for part number.)	
			Solder	

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1-1 for the following steps.

() Position the charger case as shown in the Pictorial.

() Refer to Detail 1-1A and install a 4-40 twist-in nut in hole CA of the charger case as follows:

1. Refer to Part A of the Detail and turn a 4-40 nut all the way onto the end of the hex spacer. Then turn a 4-40 twist-in nut all the way onto the hex spacer. Be sure to install the twist-in nut straight into the case. Use a nut driver if one is available.

2. Refer to Part B of the Detail and carefully turn the twist-in nut all the way into hole CA as shown. Then unscrew the hex spacer from the twist-in nut.

() Similarly, install twist-in nuts in the other seven holes (marked with arrows). Save the hex spacer and 4-40 nut for use during the assembly of the Transceiver.

NOTE: When a step directs you to prepare a solid wire, as in the next step, first cut the wire to the indicated length. Then remove 1/4″ of insulation from each end.

() Refer to Detail 1-1B and prepare the lamp as follows:

1. Prepare two 2″ white solid wires. Then form a small hook in one end of each wire.

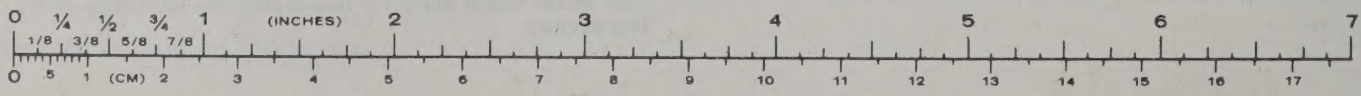
2. Form a small hook in the end of each lamp lead.

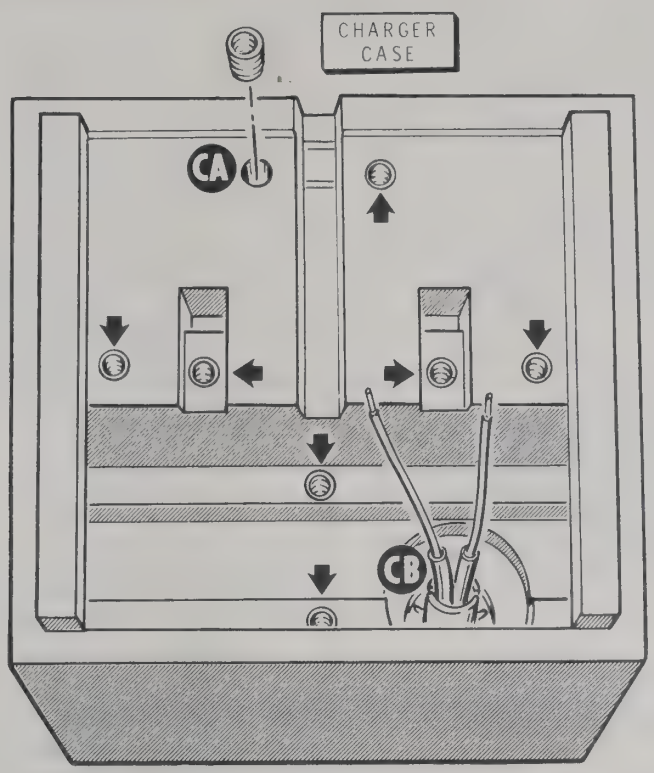
3. Connect the hook on the end of each white wire to the hook on the end of each lamp lead as shown. Then solder the connections.

4. Cut two 1″ lengths of small sleeving.

5. Slide a length of sleeving onto each white wire until the sleeving is against the lamp body.

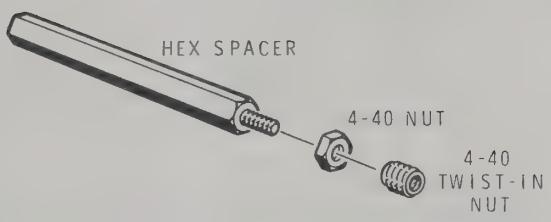
() PL301: Push the red lens into hole CB of the charger case and secure it with a lamp retainer as shown. Then carefully push the lamp into the red lens as shown. Be sure the sleeving on each lamp lead stays against the lamp body. NOTE: You may have to enlarge this hole.





PICTORIAL 1-1

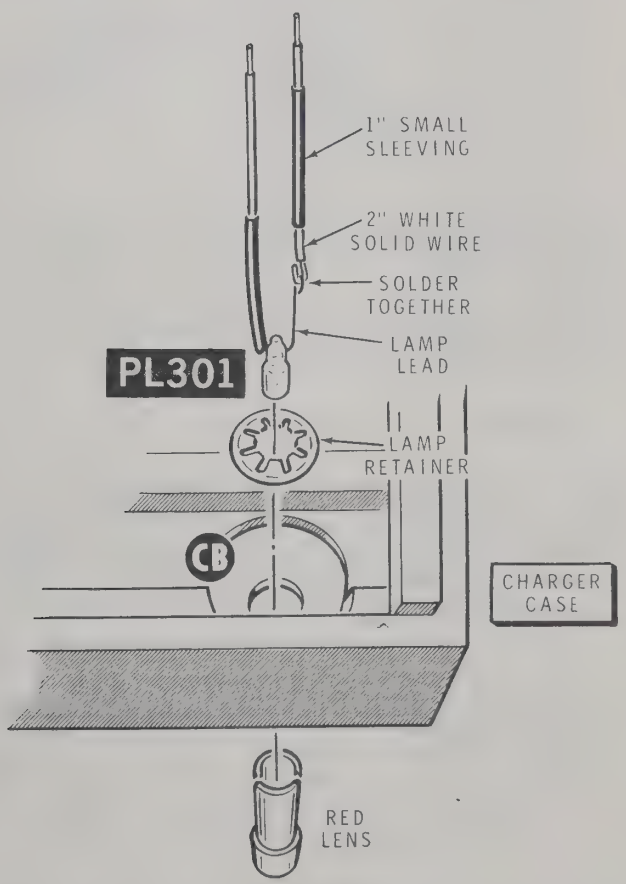
PART A



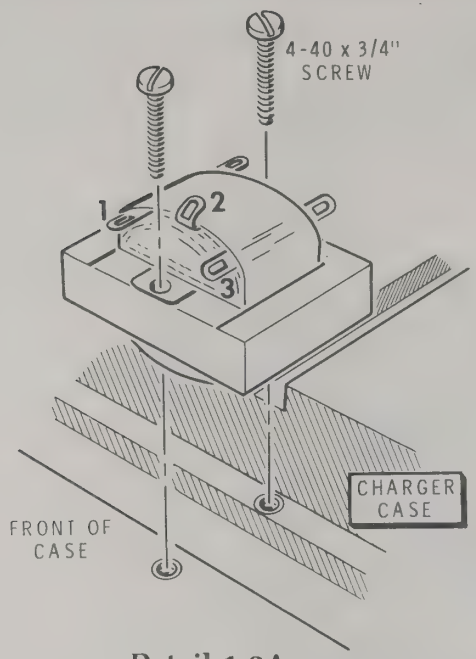
PART B



Detail 1-1A



Detail 1-1B



Detail 1-2A

Refer to Pictorial 1-2 (Illustration Booklet, Page 2) for the following steps.

() T301: Refer to Detail 1-2A and bend transformer lug 2 over as shown. Then mount the power transformer in the charger case. Use two 4-40 × 3/4" screws. Be sure to position the transformer so lugs 1, 2, and 3 are toward the front of the case as shown in the Pictorial.

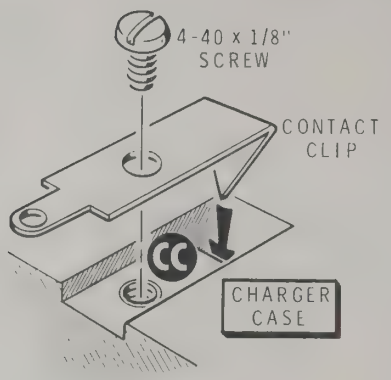
() Refer to Detail 1-2B and mount a contact clip at CC in the charger case as shown. Use a 4-40 × 1/8" screw.

() Similarly, use a 4-40 × 1/8" screw to mount a contact clip at CD in the charger case.

() Prepare a 1" white solid wire.

NOTE: In the following steps, (NS) means not to solder because you will add other wires later. "S-", with a number following it, such as (S-3), means to solder the connection. The number following the "S-" tells you how many wires should be at the connection.

() Connect one end of the prepared white wire to T301 lug 4 (NS). The other end will be connected later.



Detail 1-2B

() Refer to the following information and solder the wire to T301 lug 4 as shown. NOTE: The lug shown in the illustration on Page 11 may look different than the one on your transformer.

() Check the soldered connection. Compare it to the illustrations on the next page.

() Connect the free end of the white wire coming from T301 lug 4 to contact clip CC (S-1).

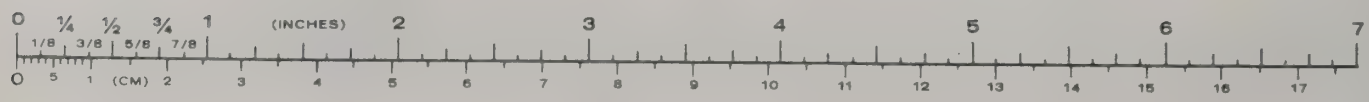
() Connect one lead of lamp PL301 to T301 lug 5 (NS) and the other lead to contact clip CD (NS).

() R301: Cut each lead of a 47 Ω (yellow-violet-black) resistor to 1/2". Then connect the resistor from T301 lug 5 (S-2) to contact clip CD (S-2).

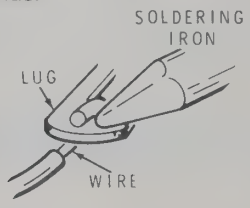
() Separate the leads at the free end of the line cord for a length of 1-1/4". Then remove 1/4" of insulation from the end of each lead. Twist together the fine strands at the end of each lead and melt a small amount of solder on the wire ends to hold the strands together.

NOTE: When you are directed to "make a mechanically secure connection", as in the next step, refer to inset drawing #1 on the Pictorial.

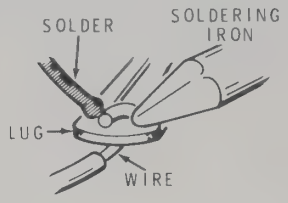
() Route the line cord as shown and connect either line cord lead to T301 lug 1 (S-1). Make a mechanically secure connection.



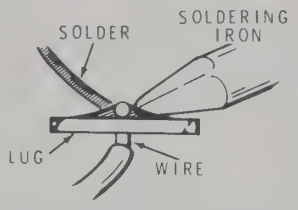
1. Push the soldering iron tip against the wire **and** the lug. Heat both the wire and the lug for two or three seconds.



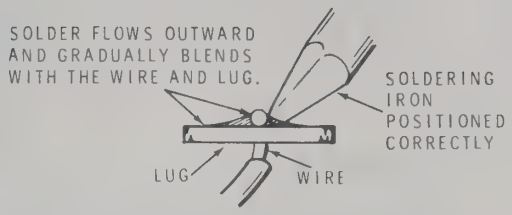
2. Apply solder to the wire and the lug, **not** to the soldering iron. IMPORTANT: Let the heat of the wire and lug melt the solder.



3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.

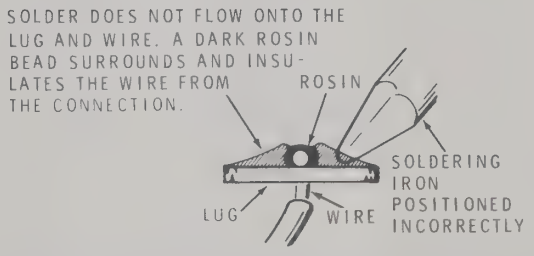


A GOOD SOLDER CONNECTION

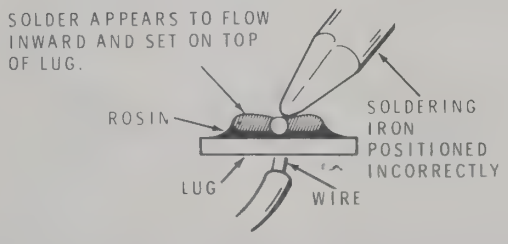


When both the wire and the lug are heated at the same time, the solder will flow onto the wire and the lug evenly. The solder will make a good electrical connection between the wire and the lug.

POOR SOLDER CONNECTIONS



When the wire is not heated sufficiently, the solder will not flow onto the wire as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



When the lug is not heated sufficiently, the solder will blob on the lug as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 VAC line voltage and the other for 240 VAC line voltage. In the U.S.A., 120 VAC is most often used, while in foreign countries 240 VAC is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

120 VAC Wiring

() Refer to Pictorial 1-2 and connect the free end of the remaining line cord lead to T301 lug 3 (S-1). Make a mechanically secure connection.

NOTE: You will have a .22 μF Mylar capacitor left over. This capacitor is used for 240 VAC wiring only.

Proceed to "Final Charger Assembly."

240 VAC Wiring

() Refer to inset drawing #2 on the Pictorial and connect the free end of the remaining line cord lead to T301 lug 2 (NS). Make a mechanically secure connection.

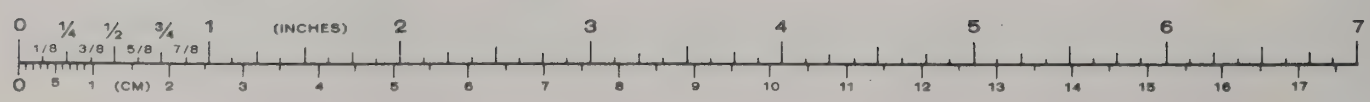
() Cut a 1" length and a 1/2" length of small sleeving.

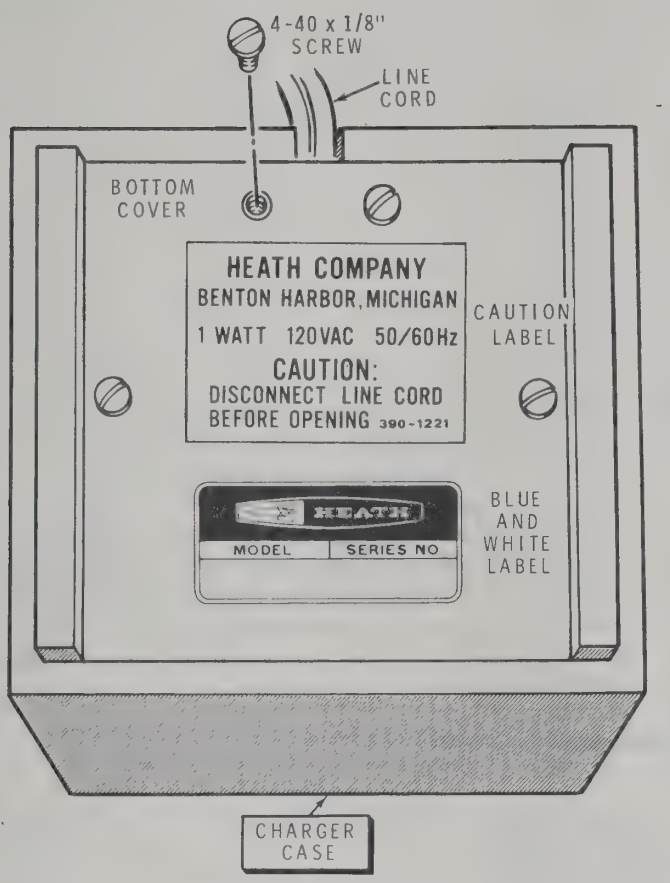
() Cut one lead of a .22 μF Mylar capacitor to 1-1/8" and the other lead to 3/4".

() C301: Slide a 1" length of small sleeving on the longer capacitor lead. Then connect this lead to T301 lug 2 (S-2).

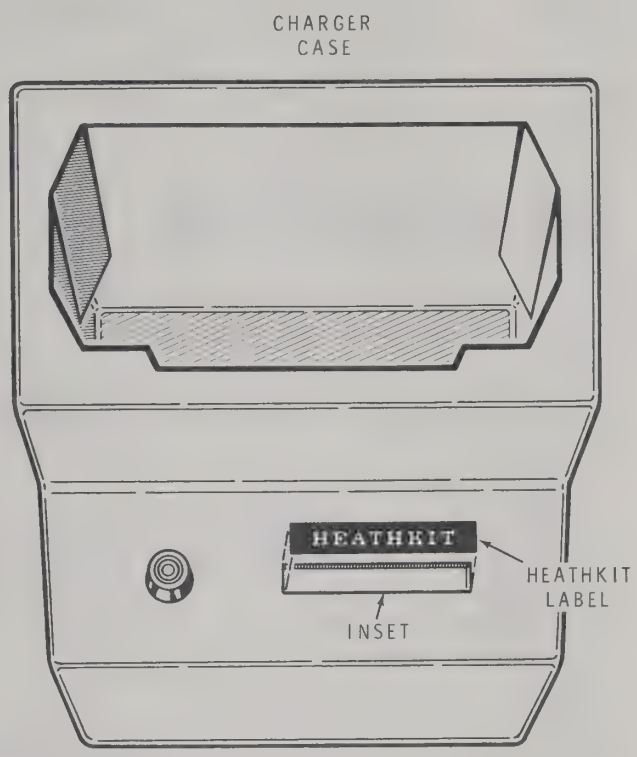
() Slide a 1/2" length of small sleeving on the shorter capacitor lead. Then connect this lead to T301 lug 3 (S-1).

Proceed to "Final Charger Assembly."





PICTORIAL 1-3



PICTORIAL 1-4

FINAL CHARGER ASSEMBLY

Refer to Pictorial 1-3 for the following steps.

() Mount the bottom cover onto the charger case. Use four 4-40 × 1/8" screws. Be sure the line cord is in the groove in the bottom of the charger case as shown.

() Carefully peel the backing paper from the caution label. Then press the label onto the bottom cover as shown.

NOTE: Complete the next step only if you wired your charger for 240 VAC operation.

() With a pen, change "120" to "240" on the caution label.

NOTE: The blue and white label shows the Model Number and the Production Series Number of your kit. Refer to these numbers in any communications with the Heath Company about your kit. This assures you that you will receive the most complete and up-to-date information in return.

() Carefully peel the backing paper from the blue and white label. Then press the label onto the bottom cover as shown.

() Carefully peel the backing paper from the Heathkit label. Then refer to Pictorial 1-4 and press the label into the inset in the top of the charger case as shown.

This completes the assembly of the battery charger. Save the leftover labels and other parts for use in a later section of this Manual. Proceed to the "Transceiver" section of this Manual.

TRANSCEIVER

PARTS LIST

() Unpack the remainder of the kit. Then check each part against the following list. The key numbers correspond to the numbers on the "Transceiver Parts Pictorial" (Illustration Booklet, Page 3).

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Customer Service" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

RESISTORS

NOTES:

1. Resistors may be packed in more than one envelope. Open all of the resistor envelopes before you check the resistors against the following list.
2. The following resistors have a tolerance of 5%. 5% is indicated by a gold fourth color band.

1/4-Watt

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-470-12	2	47 Ω (yellow-violet-black)	R31, R118
A1	6-560-12	1	56 Ω (green-blue-black)	R122
A1	6-101-12	3	100 Ω (brown-black-brown)	R14, R113, R203
A1	6-221-12	5	220 Ω (red-red-brown)	R4, R9, R72, R103, R107
A1	6-271-12	1	270 Ω (red-violet-brown)	R48
A1	6-331-12	1	330 Ω (orange-orange-brown)	R85
A1	6-471-12	1	470 Ω (yellow-violet-brown)	R116
A1	6-561-12	2	560 Ω (green-blue-brown)	R62, R86
A1	6-821-12	1	820 Ω (gray-red-brown)	R26
A1	6-102-12	10	1000 Ω (brown-black-red)	R18, R21, R24, R47, R67, R73, R97, R109, R123, R125
A1	6-152-12	3	1500 Ω (brown-green-red)	R63, R95, R119
A1	6-182-12	1	1800 Ω (brown-gray-red)	R83
A1	6-222-12	2	2200 Ω (red-red-red)	R5, R121
A1	6-332-12	2	3300 Ω (orange-orange-red)	R19, R112
A1	6-392-12	3	3900 Ω (orange-white-red)	R22, R23, R87
A1	6-472-12	19	4700 Ω (yellow-violet-red)	R12, R17, R28, R49, R51, R52, R53, R54, R55, R56, R57, R58, R61, R65, R74, R75, R76, R82, R96, R105
A1	6-562-12	1	5600 Ω (green-blue-red)	R13
A1	6-682-12	3	6800 Ω (blue-gray-red)	R15, R37, R59

HEATHKIT®

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (cont'd.)				
A1	6-103-12	20	10 kΩ (brown-black-orange)	R27, R32, R35, R41, R43, R44, R45, R64, R66, R69, R71, R77, R91, R102, R106, R108, R111, R115, R117, R124
A1	6-123-12	1	12 kΩ (brown-red-orange)	Test
A1	6-153-12	1	15 kΩ (brown-green-orange)	R16
A1	6-183-12	2	18 kΩ (brown-gray-orange)	R25, R78
A1	6-223-12	2	22 kΩ (red-red-orange)	R33, R81
A1	6-273-12	2	27 kΩ (red-violet-orange)	R99, R104
A1	6-333-12	2	33 kΩ (orange-orange-orange)	R1, R7
A1	6-473-12	9	47 kΩ (yellow-violet-orange)	R2, R8, R11, R12, R38, R39, R68, R89, R101
A1	6-683-12	1	68 kΩ (blue-gray-orange)	R79*
A1	6-823-12	1	82 kΩ (gray-red-orange)	R34
A1	6-104-12	9	100 kΩ (brown-black-yellow)	R3, R6, R29, R36, R42, R92, R93, R94, R98
A1	6-124-12	1	120 kΩ (brown-red-yellow)	R79*
A1	6-224-12	2	220 kΩ (red-red-yellow)	R79*, R84
Other Resistors				
A2	6-100	1	10 Ω, 1/2-watt (brown-black-black)	R46
A3	1-43-1	1	51 Ω, 1-watt (green-brown-black)	Dummy load
CAPACITORS				
NOTE: Capacitors may be marked by value or by the industry standard shown in parentheses.				
Ceramic				
B1	21-737	1	1.8 pF	C66
B1	21-739	2	2.2 pF	C19, C23
B1	21-701	2	3.3 pF	C4, C73
B1	21-702	2	5 pF	C8, C77
B1	21-703	5	6.8 pF	C9, C13, C15, C115, C125
B1	21-705	5	10 pF	C1, C71, C78, C107, C113
B1	21-707	2	15 pF	C74, C127
B1	21-718	1	20 pF	C111
B1	21-742	4	22 pF	C103, C106, C124, C126
B1	21-743	2	27 pF	C96, C99
B1	21-709	2	36 pF	C22, C128
B1	21-710	5	47 pF	C2, C18, C21, C64, C93
B1	21-750	1	56 pF (560)	C92
B1	21-738	9	68 pF (680)	C52, C53, C54, C55, C56, C57, C58, C59, C67
B1	21-744	2	82 pF (820)	C65, C101
B1	21-715	4	150 pF (151)	C25, C27, C63, C68
B1	21-746	1	180 pF (181)	C91
B1	21-722	2	330 pF (331)	C201, C202
B1	21-711	20	470 pF (471)	C3, C5, C6, C7, C12, C14, C26, C61, C72, C75, C76, C81, C84, C102, C104, C108, C109, C114, C116, C123
B1	21-745	2	1500 pF (152)	C42, C88
B1	21-752	6	.1 μF (104)	C39, C41, C43, C44, C79, C119
B1	21-717	19	.01 μF (103)	C16, C17, C24, C28, C29, C31, C32, C34, C35, C36, C62, C69, C80, C86, C89, C94, C95, C112, C118
B1	21-751	2	.047 μF (473)	C38, C85

*User selected part

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Tantalum				
B2	25-200	7	.68 μF	C33, C47, C48, C82, C83, C87, C98
B3	25-197	1	1 μF (1 k)	C37
B2	25-220	2	10 μF	C11, C51
B3	25-211	1	33 μF	C49
B2	25-282	2	68 μF	C45, C46
Other Capacitors				
B4	20-702	1	82 pF mica	C117
B5	28-11	3	.47 pF phenolic (yellow-violet-gray-gold)	C97, C105, C122
INDUCTORS				
C1	40-1784	7	.11 μH coil (red)	L26, L31, L32, L34, L35, L36, L39
C1	40-1785	2	.31 μH coil (violet)	L22, L23
C1	40-1782	1	.2 μH coil (orange)	L3
C1	40-1783	4	.14 μH coil (yellow)	L1, L2, L24, L37
C2	40-1926	8	2 μH coil	L13, L14, L15, L16, L17, L18, L19, L20
C3	45-605	1	.10 μH choke (silver-gold-brown-black-silver)	L40
C3	45-606	3	1 μH choke (silver-brown-gold-black-silver)	L21, L25, L33
C3	45-609	1	2.2 μH choke (silver-red-gold-red-gold)	L12
C3	45-607	1	22 μH choke (silver-red-red-black-gold)	L11
C3	45-608	1	39 μH choke (silver-orange-white-black-gold)	L10
C3	45-604	7	100 μH choke (silver-brown-black-brown-silver)	L5, L8, L9, L27, L28, L29, L30
C4	52-182	3	IF transformer	L4, L6, L7
C5	475-10	4	Ferrite bead	
DIODES				
D1	56-26	2	1N191 (brown-white-brown)	D8, D18
D1	56-54	1	VRS-5A zener (8.5 V)	D14

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Diodes (cont'd.)				
D1	56-56	8	1N4149	D1, D2, D5, D6, D7, D9, D10, D12
D1	56-97	1	1N3017 zener (7.5 V)	D4
D1	56-646	4	BA-244 (red-yellow-yellow)	D11, D15, D16, D17
D2	56-648	1	MV109 varactor	D3
D1	57-27	1	1N2071	D13

TRANSISTORS—INTEGRATED CIRCUITS (IC's)

NOTE: Transistors and integrated circuits may be marked for identification in any of the following four ways:

1. Part number.
2. Type number. (On integrated circuits, this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number and a type number other than the one listed.

D3	417-118	1	2N3393 transistor	Q5
D4	417-154	1	2N2369 transistor	Q16
D3	417-201	2	X29A829 transistor	Q6, Q7
D5	417-274	4	40673 transistor	Q1, Q2, Q3, Q13
D3	417-934	4	2N5770 transistor, selected	Q10, Q11, Q14, Q15
D6	417-819	1	MJE171 transistor	Q8
D3	417-887	3	MPSH10 transistor	Q4, Q9, Q12
D4	417-912	1	MRF237 or SD1127 transistor	Q17
D7	442-21	2	MC1458 IC	IC3, IC4
D8	442-92	1	3089 IC	IC1
D9	442-610	1	TBA820L IC	IC2

CONTROLS—SWITCHES

E1	10-1112	1	20 kΩ control	R88
E1	10-1113	1	1000 Ω (1 kΩ) control	R114
E2	10-1157	1	5 kΩ control	R201
E3	19-742	1	5 kΩ control with switch	R202/SW201
E4	61-34	1	Toggle switch	SW203
E5	63-1318	1	Rotary switch	SW202

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
CRYSTALS—FILTERS				
F1	404-596	1	11.3 MHz crystal	Y9
F1	404-598	1	15.1378 MHz crystal (For 146.94 MHz)	Y1
F2	404-599	1	10.7 MHz filter	FL3
F2	404-600	1	Set of two matched 10.7 MHz filters	FL1, FL2
F1	404-602	1	10.1 MHz crystal	Y11
F1	404-603	1	10.7 MHz crystal	Y10
OTHER ELECTRONIC COMPONENTS				
G1	401-62	1	Earphone	
G2	401-176	1	Speaker	SP201
G3	418-27	10	1.2-volt battery	B1
G4	421-35	1	2-ampere miniature fuse	F1
G5	480-71	1	Microphone element	A201
CONNECTORS				
H1	432-59	1	BNC jack	J202
H2	432-878	24	Crystal socket pin	
H3	432-997	1	BNC shell	
H4	436-48	1	Phone jack	J201
HARDWARE				

NOTE: Hardware may be packed in more than one envelope. Open all of the hardware packets before you check the hardware against the following list.

#2 Hardware

J1	250-467	2	2-56 × 3/16″ screw
J2	252-98	2	2-56 nut

#3 Hardware

J3	253-94	2	#3 flat washer

#4 Hardware

J4	250-321	4	4-40 × 1/8″ screw
J5	250-285	2	4-40 × 1/4″ screw
J6	250-1106	6	4-40 × 5/16″ black flat head screw
J7	250-273	4	4-40 × 3/8″ screw
J8	252-2	4	4-40 nut
J9	252-711	12	4-40 twist-in nut
J10	253-164	1	#4 formed washer
J11	255-741	12	4-40 threaded spacer

Other Hardware

K1	250-1286	2	6-32 × 1/4″ "T" bolt
K2	252-3	2	6-32 nut
K3	252-159	4	Control nut
K4	253-170	1	Control flat washer
K5	254-42	1	Control lockwasher
K7	258-730	4	Spring retainer
K8	259-1	3	#6 solder lug
K9	259-12	4	1/4″ solder lug (2 extra)
K10	259-27	1	Control solder lug
K11	475-20	2	Aluminum coil core

MISCELLANEOUS

L1	73-92	2	Foam gasket
	74-6	1	Roll of tape
	75-109	1	Insulator paper (5-3/8″ × 3-3/8″)
	85-2231	1	Circuit board
L2	142-729	1	Antenna SWITCH
L3	205-778	1	1″ blade
L4	92-684	1	PTT bezel
L5	205-1782	1	Left side rail
L6	258-716	1	Spring clip
L7	266-985	1	PTT bar
L8	266-1040	1	Spring contact
L9	205-1748	1	Right side rail
L10	206-1279	1	Lateral shield
L11	206-1280	1	Foil shield
L12	206-1289	1	Coil shield
L13	258-717	2	Side bracket
	305-70	1	Set of case parts consists of:
L14	*92-680*	*1*	*Case top*
L15	*92-681*	*1*	*Case front*
L16	*92-682*	*1*	*Case bottom*
L17	*92-683*	*1*	*Case back*
L18	462-1079	3	Knob
	490-185	1	Package of desoldering braid
L19	490-191	1	Alignment tool
L20	490-5	1	Nut starter
	85-2199	1	MAIN CIRCUIT BOARD

SPECIAL ASSEMBLY NOTES

IMPORTANT: Before you start to assemble the circuit board, it is very important that you read the following information on wiring, soldering, and step-by-step assembly procedures.

1. The circuit board has foil on both sides. Note that the "component" (or screened) side of the circuit board has the outline of each component screened on it. With a couple of exceptions, all components will be mounted on this side of the circuit board and soldered to the other side of the circuit board. **DO NOT** solder on the component side of the circuit board unless a step specifically directs you to do so.

2. The circuit board is divided into six sections. Except for the wires, all components will be installed in one section before you proceed to another section. An identification drawing at the top of each page shows which section of the circuit board you are installing components in.

3. Due to the small foil area around the circuit board holes, and the small area between the foils, be very careful to prevent solder bridges between adjacent foils. Use a minimum amount of solder and a 25- to 40-watt soldering iron with a 1/8" chisel or pyramid tip. Allow the iron to reach operating temperature; then apply it only long enough to make a good solder connection. Remember to keep the soldering iron tip clean.

CONSTRUCTION HINTS

The assembly of this circuit board is not difficult; but it **is** time consuming. The following valuable hints will help you do a good assembly job.

A. Take your time when you assemble the circuit board. Work at a slow pace. Remember that accuracy is far more important than speed. Work with a good light to help reduce eye strain.

B. When you perform the steps in the circuit board Pictorials, identify each component and the location **before** you install the component. (It may be very difficult to locate an incorrectly installed component after the unit has been assembled.) Then position each component over its outline on the circuit board as shown in the Detail drawing.

C. After you complete the steps in one of the six sections of the circuit board, carefully inspect that section for improperly installed components, unsoldered connections, or solder bridges between adjacent foils. It may be helpful to check the foil on your circuit board against the foil shown in the "X-Ray Views" section (Illustration Booklet, Page 15).

D. Take a short break after you complete each one-half or a full section of the circuit board.

E. If you find it necessary to remove a component from the circuit board, use the desoldering braid supplied with this kit. Follow the directions on the package.

F. Because the circuit board is so crowded, there is not sufficient room on it to print the value of each component. Therefore, most components follow the outlines shown in Figure A.

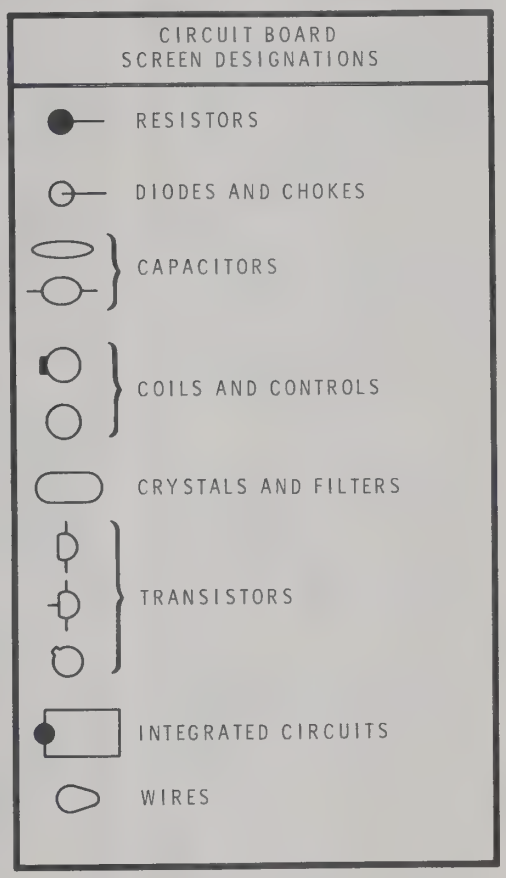


Figure A



STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD ASSEMBLY

START

Position the main circuit board as shown. Then complete each step on the following Pictorials.

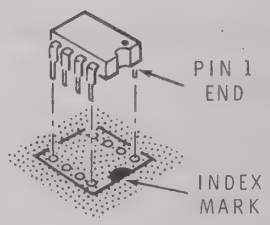
IMPORTANT: You will install many components on this circuit board. Many of them are very close together. Therefore, take your time and work carefully to avoid making a mistake.

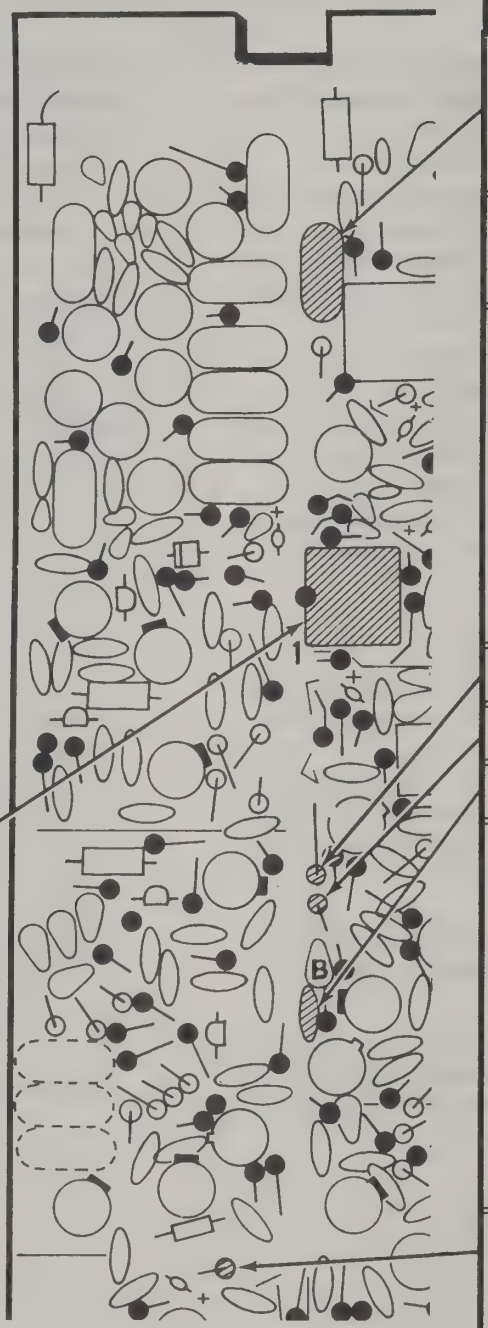
NOTE: Be sure to install each of the following components at the correct location. They will be used to help you properly install the lateral shield later.

(✓) IC4: MC1458 integrated circuit (#442-21). Use the following procedure to install this IC:

1. Refer to Detail 2-1A and locate the pin 1 end of the IC. It may be marked in a number of ways such as a notch, triangle, dot, the numeral 1, etc.

2. Postion the pin 1 end of the IC over the index marked on the circuit board, as shown. Then insert the pins into the circuit board and solder them to the foil.



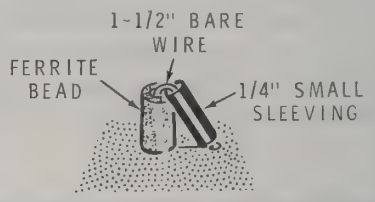


CONTINUE

(✓) FL3: 10.7 MHz filter (#404-599). This filter may be installed either way in the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

(✓) Remove the insulation from a 3" white wire. Use this wire in the next two steps.

NOTE: When a step directs you to install a ferrite bead, use a 1-1/2" length of bare wire (just prepared) and 1/4" of small sleeving as shown below.

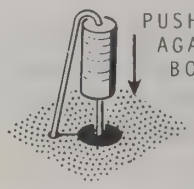


(✓) Ferrite bead.

(✓) Ferrite bead.

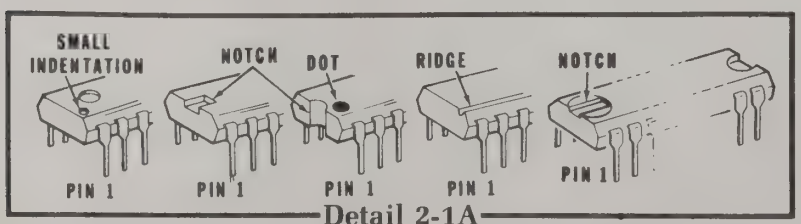
(✓) C3: 470 pF (471) ceramic.

NOTE: Mount chokes vertically to the circuit board, as shown, unless a step directs you otherwise. Be sure the choke is still vertical to the circuit board before you solder the leads to the foil.



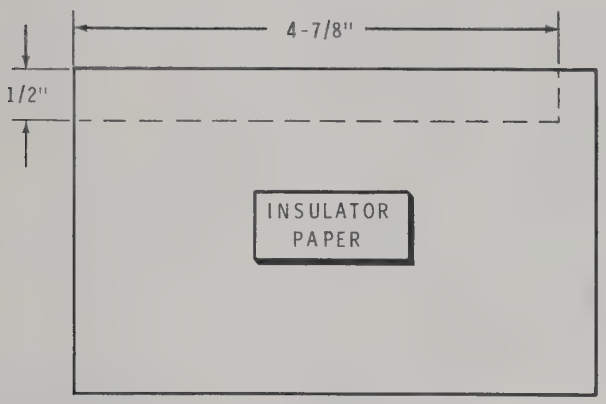
(✓) L33: 1 μH choke (#45-606, silver-brown-gold-black-silver). Read the color bands by starting at the end of the choke with the wide band.

(✓) Solder the leads to the foil and cut off the excess lead lengths.



Detail 2-1A

PICTORIAL 2-1



Detail 2-2A

Refer to Pictorial 2-2 (Illustration Booklet, Page 5) for the following steps.

(✓) Position the circuit board as shown in the Pictorial.

(✓) Cut five 1-1/4" lengths of bare wire.

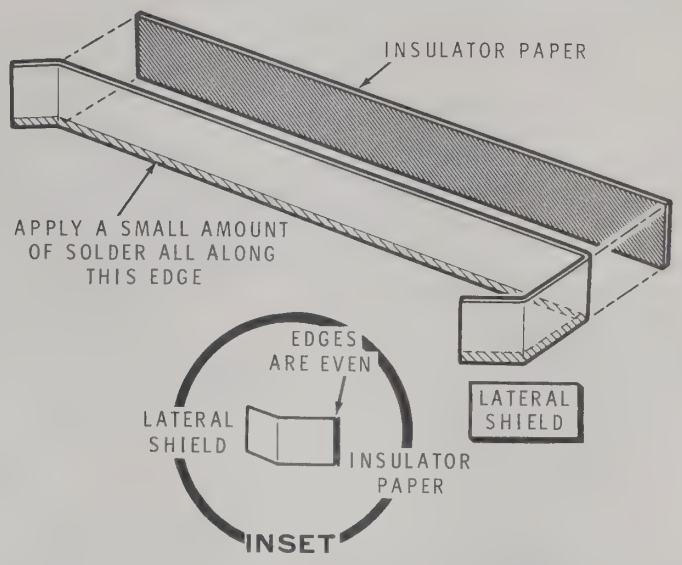
(✓) Install and solder a 1-1/4" bare wire in each of the five indicated circuit board holes. Be sure each wire is in the correct hole before you solder it to the foil. Also be sure the free end of each wire is at least 3/4" above the **component** side of the circuit board. Then cut off any excess lead lengths from the **foil** side of the circuit board.

(✓) Refer to Detail 2-2A and cut a 4-7/8" × 1/2" piece of insulator paper. Save the remaining insulator paper for use later.

(✓) Carefully peel the backing paper from the 4-7/8" × 1/2" insulator paper. Then press the insulator paper onto the long portion of the lateral shield as shown in Detail 2-2B. Make sure the top edge of the insulator paper is even with the top edge of the lateral shield, as shown in the inset drawing.

(✓) Refer again to Detail 2-2B and rub the indicated edge of the lateral shield with a pencil eraser. Then melt a small amount of solder along this edge of the shield.

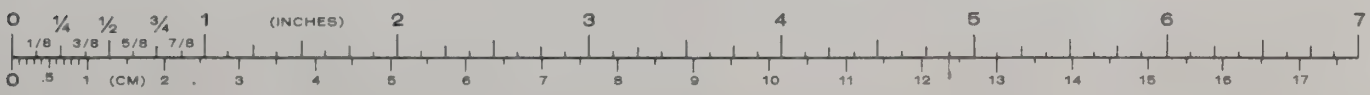
(✓) Position the lateral shield over the actual-size drawing of the shield in Detail 2-2C. Then reform the shield as necessary so it is exactly as illustrated.

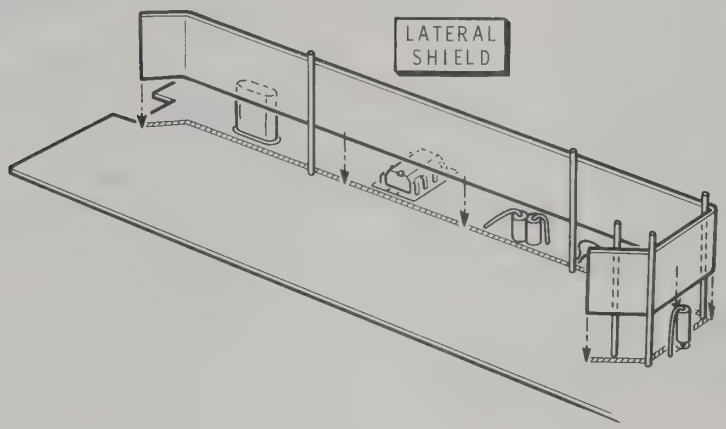


Detail 2-2B



Detail 2-2C





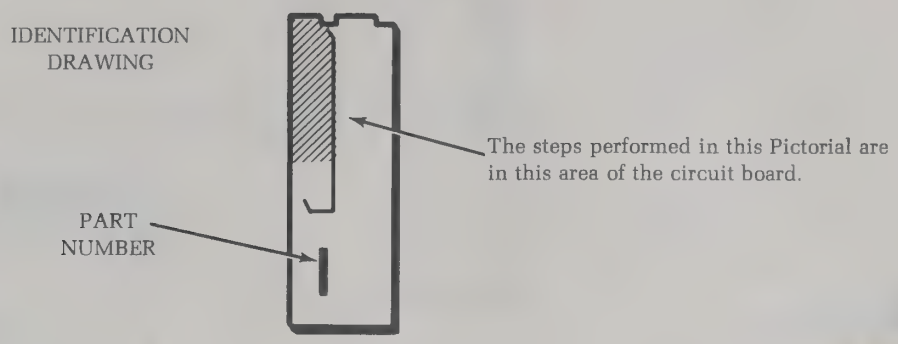
Detail 2-2D

() Refer to Detail 2-2D and install the lateral shield on the circuit board as shown. Be sure the five bare wires and the six components are on the indicated sides of the shield. Push the shield down tight against the circuit board. Then tack solder each end of the shield to the foil on the top (component) side of the circuit board.

NOTE: When you perform the next step, be sure to solder the shield to the circuit board on the side indicated in the Pictorial.

() Solder the inside edge of the shield to the circuit board for as much of its length as possible. Be careful you do not cover any of the nearby holes with solder.

() Solder each of the five bare wires to the shield. Then cut the wires at AA, AB, and AC 1/4" above the top of the shield. Cut the wires at AD and AE off even with the top of the shield.



START

Position the circuit board as shown. Then complete each step on the following Pictorials.

IMPORTANT: You will install many components on this circuit board. Many of them are very close together. Therefore, take your time and work carefully to avoid making a mistake.

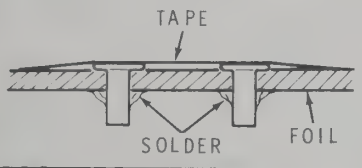
NOTE: Use the following procedure to install the crystal socket pins in the next eight steps.

A. Insert each pin until it is seated against the circuit board.

B. Place a length of tape over the pins to hold them against the circuit board.

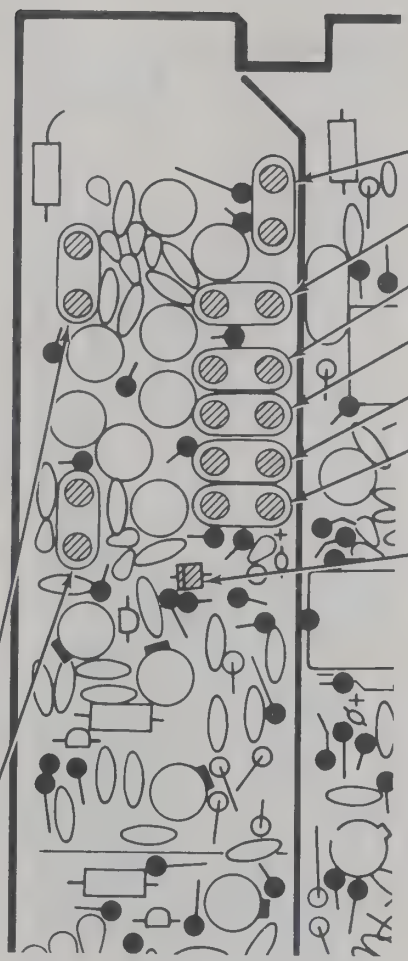
C. Turn the circuit board over and solder the pins to the foil. Do not cut off these pins.

D. Remove the tape after the connections have cooled.



() Two crystal socket pins at Y8.

() Two crystal socket pins at Y7.



CONTINUE

() Two crystal socket pins at Y1.

() Two crystal socket pins at Y2.

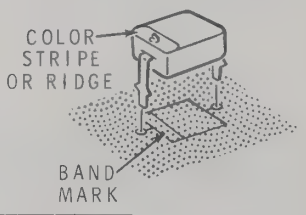
() Two crystal socket pins at Y3.

() Two crystal socket pins at Y4.

() Two crystal socket pins at Y5.

() Two crystal socket pins at Y6.

() D3: MV109 varactor diode (#56-648). Install this diode so the color stripe near one lead is toward the band mark on the circuit board. Solder the leads to the foil.



PICTORIAL 2-3



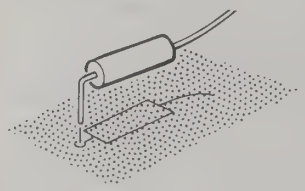
IDENTIFICATION DRAWING

The steps performed in this Pictorial are in this area of the circuit board.

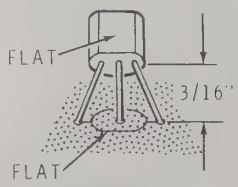
PART NUMBER

START

(✓) R203: Cut both leads of a 100 Ω (brown-black-brown) resistor to 1/2". Then insert either lead into the circuit board hole for this resistor. Position this resistor down against the circuit board as shown. Then solder the lead to the foil and cut off the excess lead length. The other resistor lead will be connected later.

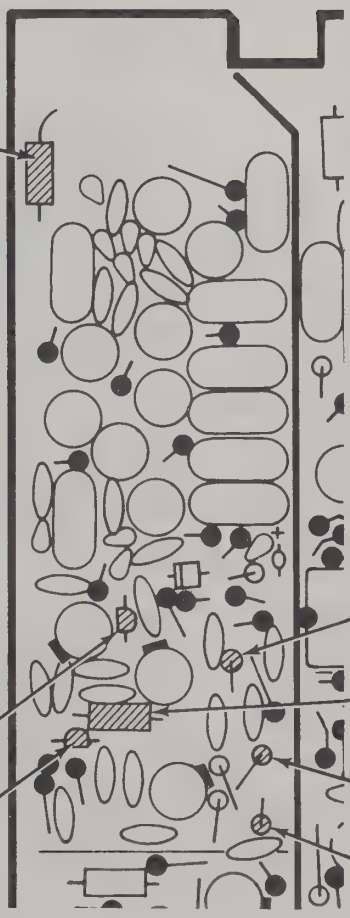


NOTE: Install the following transistors in the manner shown. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder each lead to the foil and cut off the excess lead lengths.



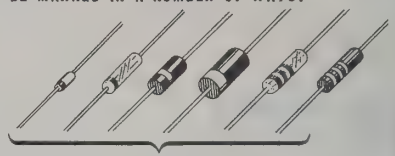
(✓) Q9: MPSH10 transistor (#417-887).

(✓) Q10: 2N5770 transistor (#417-934).



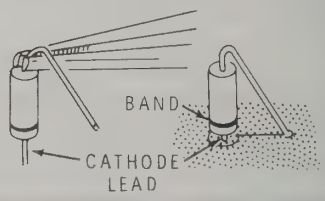
CONTINUE

IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.



NOTE: Use the following procedure when a step directs you to install a diode:

1. Hold the diode lead with pliers so you do not break the diode body.
2. Bend the lead before installing the diode.
3. Position the diode on the circuit board as directed in each step.



(✓) D4: 1N3017 zener diode (#56-97). Position the **banded end down**.

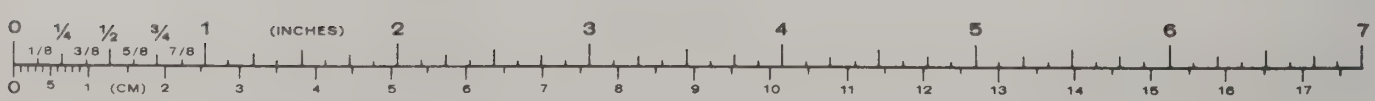
(✓) R64: 10 kΩ (brown-black-orange) resistor. NOTE: The banded end of a resistor may be positioned either way.

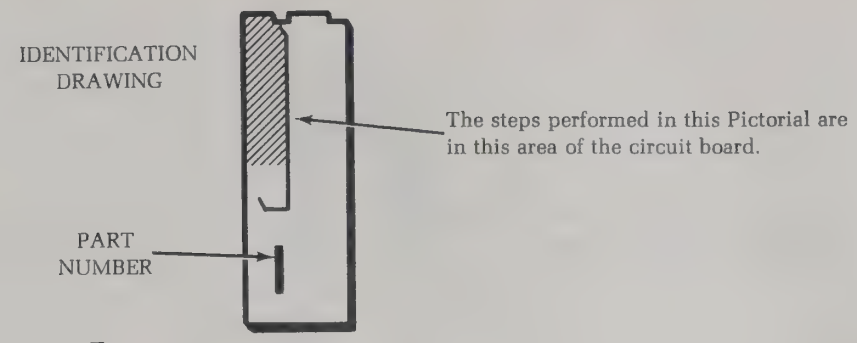
(✓) D2: 1N4149 diode (#56-56). Position the **banded end up**.

(✓) D1: 1N4149 diode (#56-56). Position the **banded end up**.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

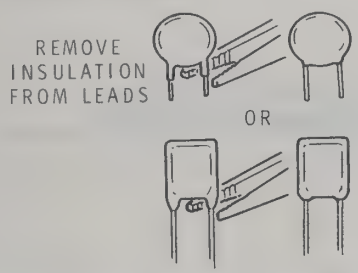
PICTORIAL 2-4





START

NOTE: Before you install ceramic capacitors, remove any insulation from the leads as shown.



(✓) C52: 68 pF (680) ceramic.

(✓) C59: 68 pF (680) ceramic.

(✓) C58: 68 pF (680) ceramic.

NOTE: Do not use the 82 pF **mica** capacitor in the next step.

(✓) C65: 82 pF (820) **ceramic**.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

(✓) C66: 1.8 pF ceramic.

(✓) C67: 68 pF (680) ceramic.

(✓) C68: 150 pF (151) ceramic.

(✓) C64: 47 pF ceramic.

(✓) C71: 10 pF ceramic.

(✓) C72: 470 pF (471) ceramic.

(✓) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

(✓) C53: 68 pF (680) ceramic.

(✓) C54: 68 pF (680) ceramic.

(✓) C55: 68 pF (680) ceramic.

(✓) C56: 68 pF (680) ceramic.

(✓) C57: 68 pF (680) ceramic.

(✓) C63: 150 pF (151) ceramic.

(✓) C62: .01 μF (103) ceramic.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

(✓) C88: 1500 pF (152) ceramic.

(✓) C118: .01 μF (103) ceramic.

(✓) C61: 470 pF (471) ceramic.

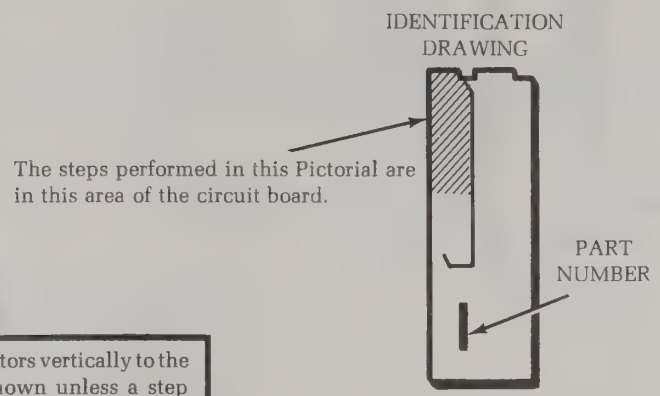
(✓) C73: 3.3 pF ceramic.

(✓) C76: 470 pF (471) ceramic.

(✓) C69: .01 μF (103) ceramic.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-5



START

NOTE: Mount resistors vertically to the circuit board as shown unless a step directs you otherwise. Be sure each resistor is still vertical to the circuit board before you solder the leads to the foil.



() R57: 4700 Ω (yellow-violet-red).

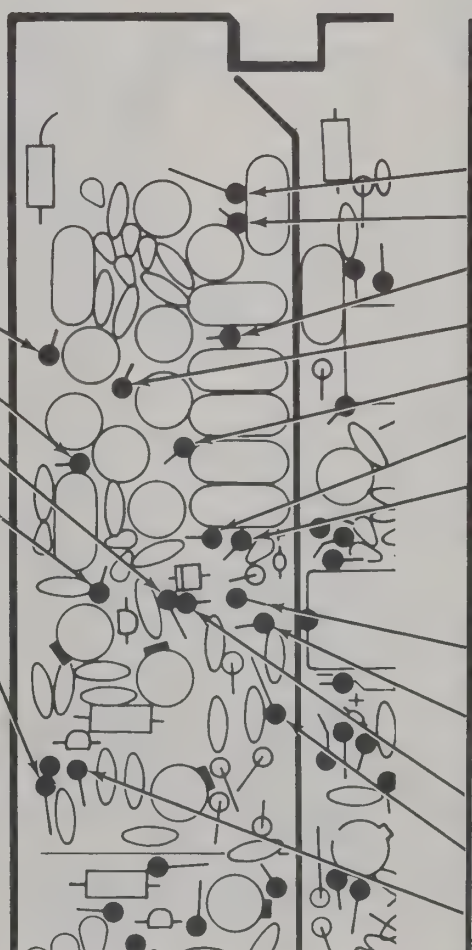
() R56: 4700 Ω (yellow-violet-red).

() R59: 6800 Ω (blue-gray-red).

() R63: 1500 Ω (brown-green-red).

() R67: 1000 Ω (brown-black-red).

() Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

Install seven 4700 Ω (yellow-violet-red) resistors at:

() R49.

() R51.

() R52.

() R53.

() R54.

() R55.

() R58.

() Solder the leads to the foil and cut off the excess lead lengths.

() R91: 10 kΩ (brown-black-orange).

() R89: 47 kΩ (yellow-violet-orange).

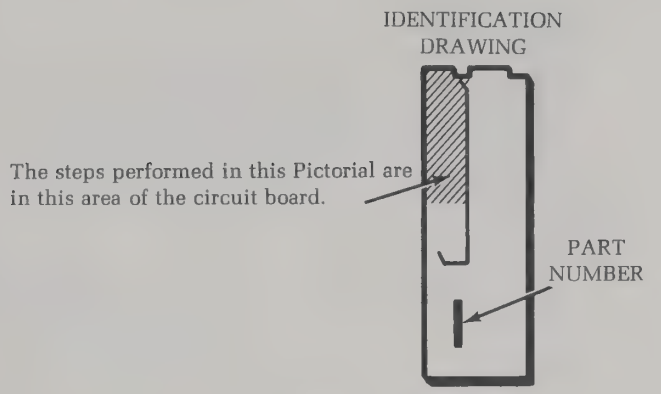
() R61: 4700 Ω (yellow-violet-red).

() R62: 560 Ω (green-blue-brown).

() R65: 4700 Ω (yellow-violet-red).

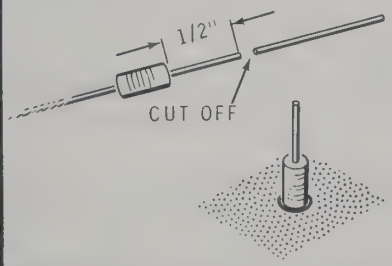
() Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-6



START

(✓) R66/TP2: Cut one lead of a 10 kΩ (brown-black-orange) resistor to 1/2". Insert the longer lead into the circuit board hole as shown. Then solder the lead to the foil and cut off the excess lead length.

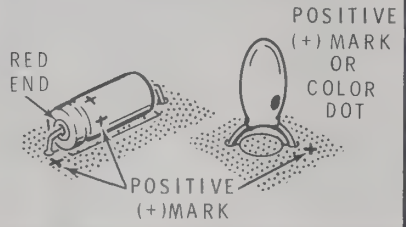


(✓) Cut a 3/4" length of small sleeving. Then slide the sleeving over the free lead of resistor R66 until the sleeving is over the body of the resistor and against the circuit board.



CONTINUE

NOTE: When you install tantalum capacitors, be sure to match the positive (+) mark or color dot on the capacitor with the positive (+) mark on the circuit board as shown.



(✓) C87: .68 μF tantalum capacitor.

NOTE: When you install chokes, as in the next three steps, read the color bands starting at the end with the wide band.

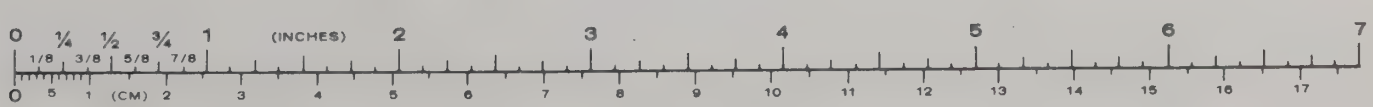
(✓) L12: 2.2 μH choke (#45-609, silver-red-gold-red-gold). Install chokes in the same manner as resistors.

(✓) L21: 1 μH choke (#45-606, silver-brown-gold-black-silver).

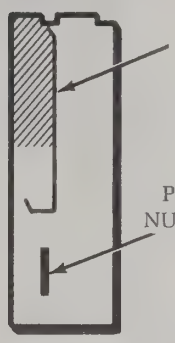
(✓) L25: 1 μH choke (#45-606, silver-brown-gold-black-silver).

(✓) Solder the leads to the foil and cut off any excess lead lengths.

PICTORIAL 2-7

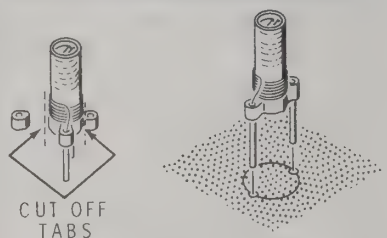


IDENTIFICATION DRAWING



() Refer to Detail 2-8A, below, and use sandpaper to shape both ends of the alignment tool as shown.

Install eight 2 μH coils (#40-1926) at the following locations. For each coil, first cut off the two indicated tabs and use the alignment tool to turn the slug until it is flush with the top of the coil form. Then insert the leads of the coil in the circuit board and solder them to the foil. Cut off any excess lead lengths.



() L13

() L14

() L15

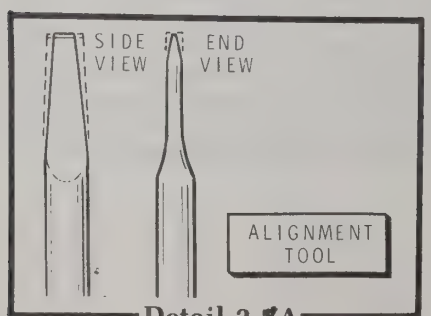
() L20

() L16

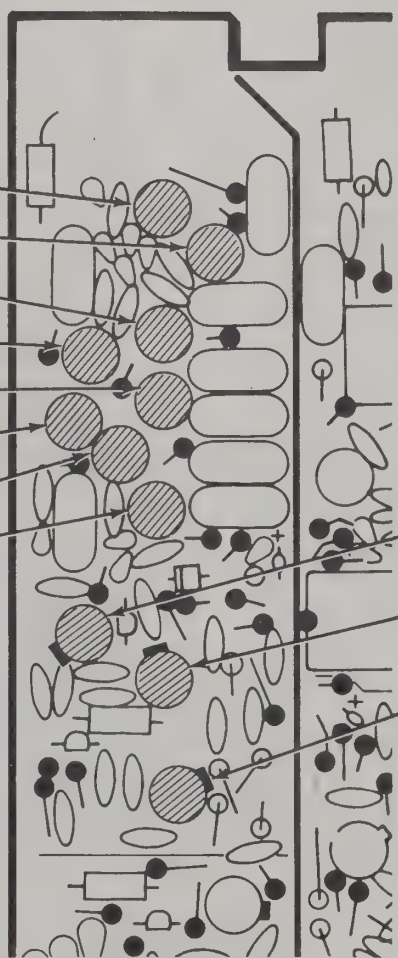
() L19

() L17

() L18

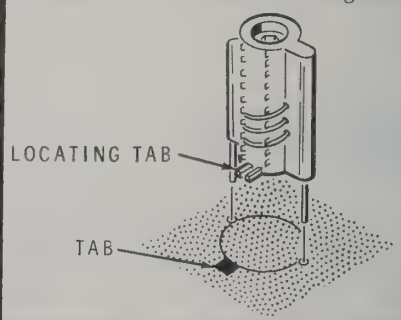


Detail 2-8A



CONTINUE

NOTE: When you install each of the following coils, position the locating tab over the outline of the tab on the circuit board. Insert the leads into the holes and push the coil against the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.



() L23: .31 μH coil (violet, #40-1785).

() L22: .31 μH coil (violet, #40-1785).

() L24: .14 μH coil (yellow, #40-1783).

NOTE: This completes the assembly of this section of the circuit board. Be sure all connections are soldered and there are no solder bridges between adjacent foils.

PICTORIAL 2-8

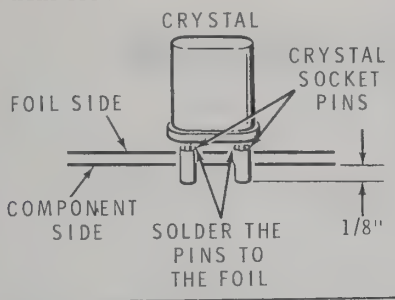
IDENTIFICATION DRAWING

The steps performed in this Pictorial are in this area of the circuit board.

PART NUMBER

START

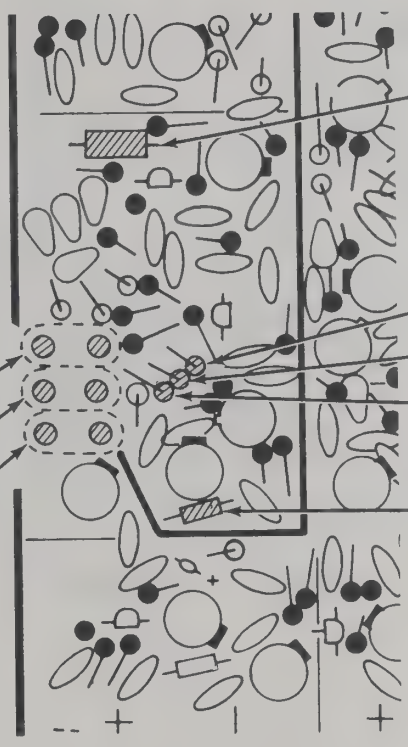
NOTE: When you install the crystal socket pins in the next three steps, insert the closed end of the pins **from the foil side** of the circuit board until 1/8" of the pins protrudes from the component side of the board. It may be helpful to place the pins on a crystal, as shown, to help hold them while you solder them **to the foil side**. Be careful you do not get solder in the pins. Be sure to remove the crystal after the connections cool.



(✓) Two crystal socket pins at 11.3.

(✓) Two crystal socket pins at 10.7.

(✓) Two crystal socket pins at 10.1.



CONTINUE

(✓) R69: 10 k (brown-black-orange). Position this resistor down against the circuit board as shown.

Install three BA-244 diodes (#56-646, red-yellow-yellow) at the following locations. **Be sure to position the end with the red band up.**

(✓) D15.

(✓) D16.

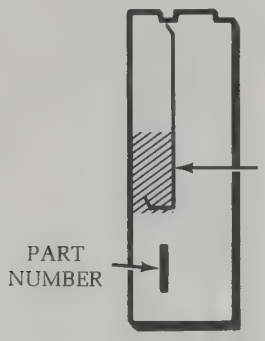
(✓) D17.

(✓) C97: .47 pF phenolic (yellow-violet-gray-gold) capacitor. Position this capacitor down against the circuit board.

(✓) Solder the leads to the foil and cut off the excess lead lenghts.

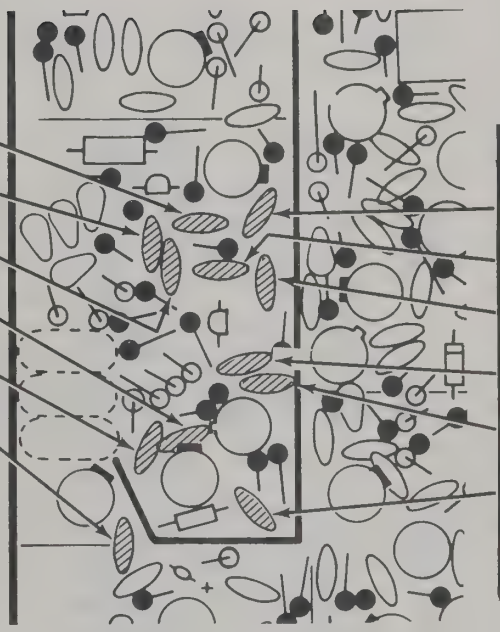
PICTORIAL 2-9

IDENTIFICATION DRAWING



START

- (✓) C74: 15 pF ceramic.
- (✓) C75: 470 pF (471) ceramic.
- (✓) C89: .01 μF (103) ceramic.
- (✓) C94: .01 μF (103) ceramic.
- (✓) C95: .01 μF (103) ceramic.
- (✓) C99: 27 pF ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

- (✓) C77: 5 pF ceramic.
- (✓) C92: 56 pF (560) ceramic.
- (✓) C78: 10 pF ceramic.
- (✓) C91: 180 pF (181) ceramic.
- (✓) C93: 47 pF ceramic.
- (✓) C96: 27 pF ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-10

IDENTIFICATION DRAWING



START

() R68: 47 kΩ (yellow-violet-orange).

() R72: 220 Ω (red-red-brown).

() R95: 1500 Ω (brown-green-red).

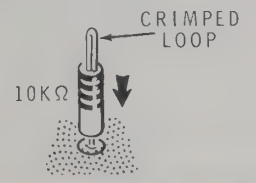
() R92: 100 kΩ (brown-black-yellow).

() R93: 100 kΩ (brown-black-yellow).

() R94: 100 kΩ (brown-black-yellow).

() Solder the leads to the foil and cut off the excess lead lengths.

() R102/TP4: Cut one lead of a 10 kΩ (brown-black-orange) resistor to 3/8". Form this lead into a loop; then crimp the loop tightly as shown. Insert the longer lead into the circuit board hole. Solder the lead to the foil and cut off the excess lead length.



() Cut a 3/8" length of small sleeving. Then slide the sleeving over the free lead of resistor R102 until the sleeving is against the circuit board.



CONTINUE

() R13: 5600 Ω (green-blue-red).

() R73: 1000 Ω (brown-black-red).

() R97: 1000 Ω (brown-black-red).

() R96: 4700 Ω (yellow-violet-red).

() R101: 47 kΩ (yellow-violet-orange).

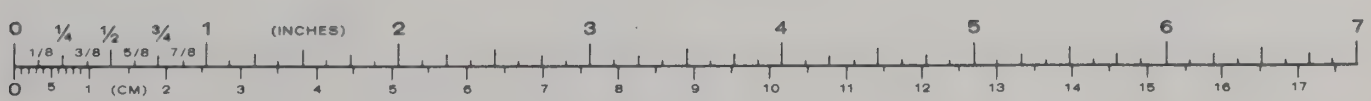
() R103: 220 Ω (red-red-brown).

() R99: 27 kΩ (red-violet-orange).

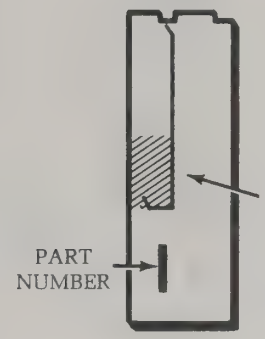
() R98: 100 kΩ (brown-black-yellow).

() Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-11

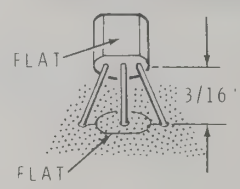


IDENTIFICATION DRAWING



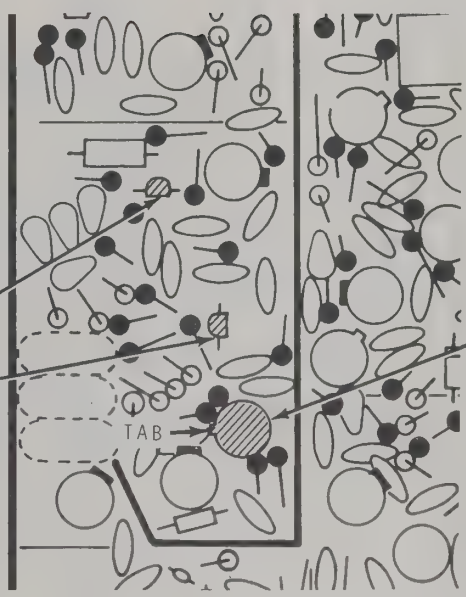
START

NOTE: Install the following transistors in the manner shown. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder each lead to the foil and cut off the excess lead lengths.



() Q11: 2N5770 transistor (#417-934).

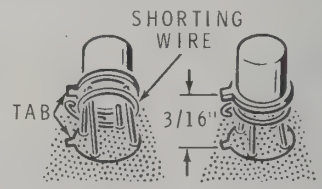
(√) Q12: MPSH10 transistor (#417-887).



CONTINUE

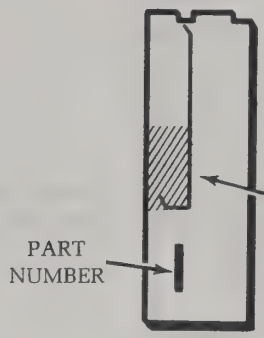
NOTE: Install the next transistor in the manner shown. First, line up the tab with the tab outline on the circuit board. Insert the transistor leads into the corresponding holes on the circuit board. Solder each lead to the foil and cut off the excess lead lengths. Then remove the shorting wire from the transistor leads.

(√) Q13: 40673 transistor (#417-274).



PICTORIAL 2-12

IDENTIFICATION DRAWING



START

Install three 100 μH chokes (#45-604, silver-brown-black-brown-silver) at the following locations. Use 1/4" of small sleeving on the top lead of each choke as shown.



(✓) L27.

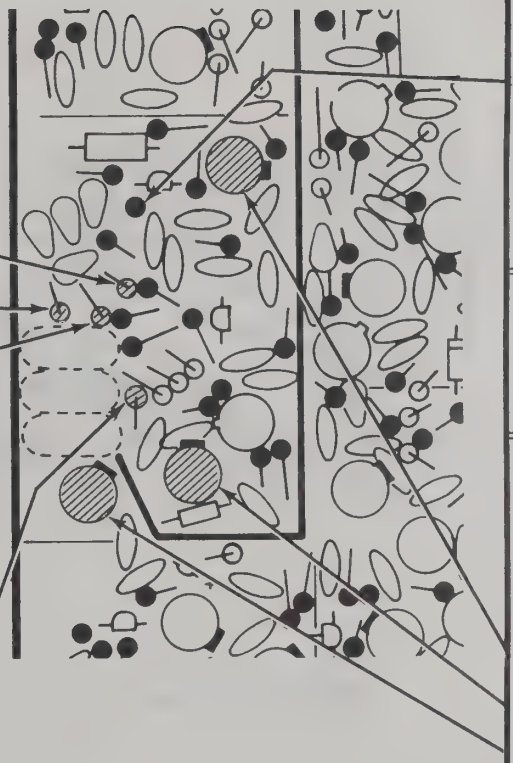
(✓) L29.

(✓) L28.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

(✓) L30: Insert one lead of a 100 μH choke (#45-604, silver-brown-black-brown-silver) into the circuit board hole inside the outline of this part. Push this end of the choke down against the circuit board and solder the lead to the foil. Cut off any excess lead length. The other choke lead will be connected later.

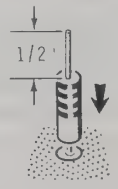




PICTORIAL 2-13

CONTINUE

(✓) R71/TP3: Cut one lead of a 10 kΩ (brown-black-orange) resistor to 1/2". Insert the longer lead into the circuit board hole as shown. Then solder the lead to the foil and cut off the excess lead length.



(✓) Cut a 3/4" length of small sleeving. Then slide the sleeving over the free lead of resistor R71 until the sleeving is against the circuit board.

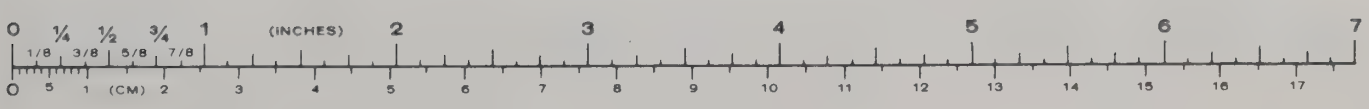
Install three .11 μH coils (red, #40-1784) at the following locations. Solder the leads to the foil and cut off the excess lead lengths as you install each coil. Be sure to position the tab on each coil as shown on the circuit board.

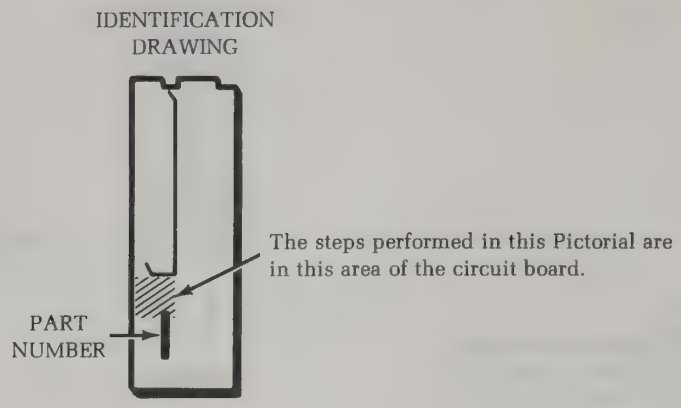
(✓) L26.

(✓) L31.

(✓) L32.

NOTE: This completes the assembly of this section of the circuit board. Be sure all connections are soldered and there are no solder solder bridges between adjacent foils.





START

NOTE: Do not use the 82 pF mica capacitor in the next step.

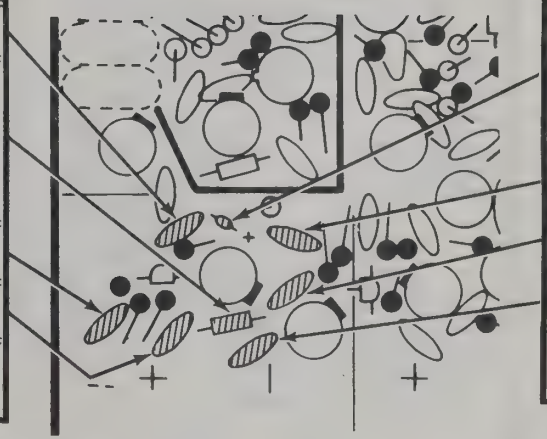
() C101: 82 pF (820) **ceramic**.

() C105: .47 pF phenolic (yellow-violet-gray-gold) capacitor. Be sure to position this capacitor down against the circuit board as shown.

() C102: 470 pF (471) ceramic.

() C103: 22 pF ceramic.

() Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

() C98: .68 μF tantalum. Be sure to match the positive (+) mark or color dot on the capacitor with the positive (+) mark on the circuit board.

() C104: 470 pF (471) ceramic.

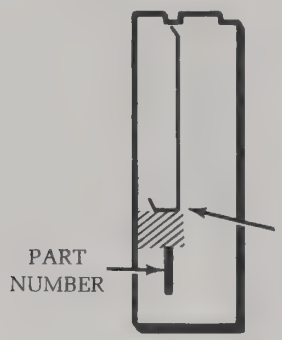
() C107: 10 pF ceramic.

() C106: 22 pF ceramic.

() Solder the leads to the foil and cut off the excess lead lengths.

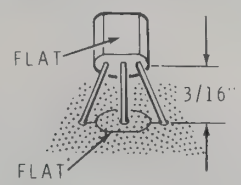
PICTORIAL 2-14

IDENTIFICATION DRAWING

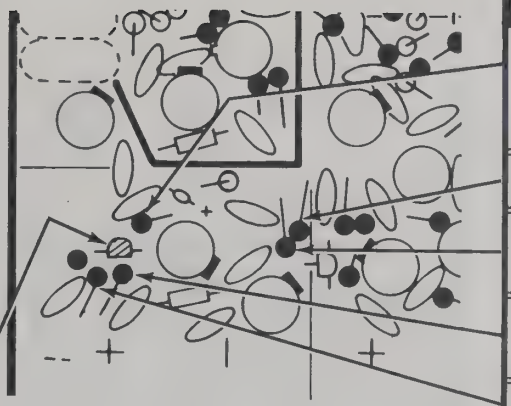


START

NOTE: Install the following transistor in the manner shown. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding hole. Solder each lead to the foil and cut off the excess lead length.



() Q14: 2N5770 transistor (#417-934).



CONTINUE

() R104: 27 kΩ (red-violet-orange). Use 1/4" of small sleeving on the lead coming from the top of this resistor.

() R109: 1000Ω (brown-black-red).

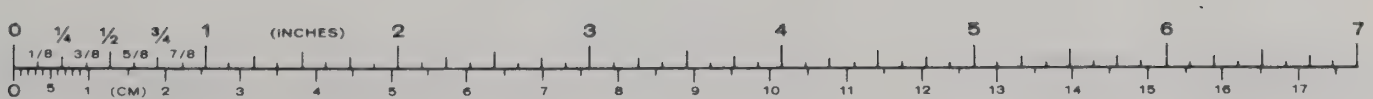
() R108: 10 kΩ (brown-black-orange).

() R105: 4700 Ω (yellow-violet-red).

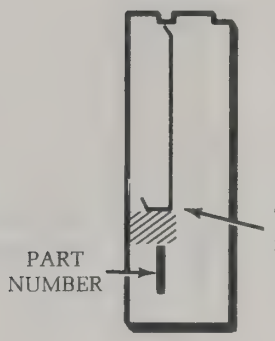
() R107: 220 Ω (red-red-brown).

() Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-15



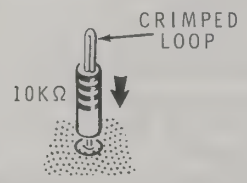
IDENTIFICATION DRAWING



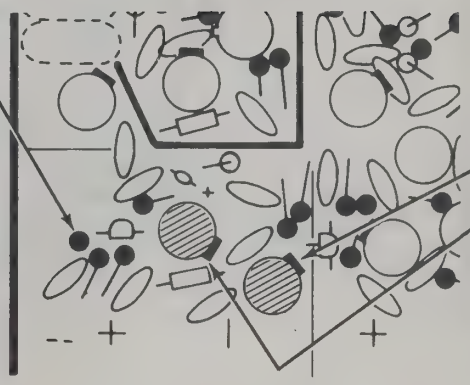
The steps performed in this Pictorial are in this area of the circuit board.

START

(✓) R106/TP5: Cut one lead of a 10 kΩ (brown-black-orange) resistor to 3/8". Form this lead into a loop; then crimp the loop tightly as shown. Insert the longer lead into the circuit hole. Then solder the lead to the foil and cut off the excess lead length.



(✓) Cut a 3/8" length of small sleeving. Then slide the sleeving over the free lead of resistor R106 until the sleeving is against the circuit board.



CONTINUE

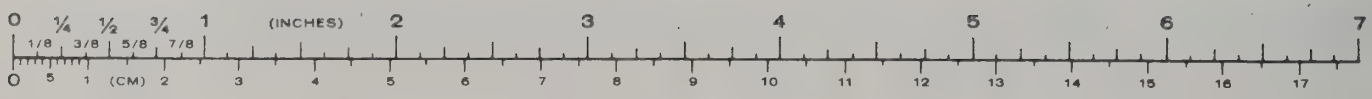
Install two .11 μH coils (red, #40-1784) at the following locations. Solder the leads to the foil and cut off the excess lead lengths as you install each coil. Be sure to position the tab on each coil as shown on the circuit board.

(✓) L35.

(✓) L34.

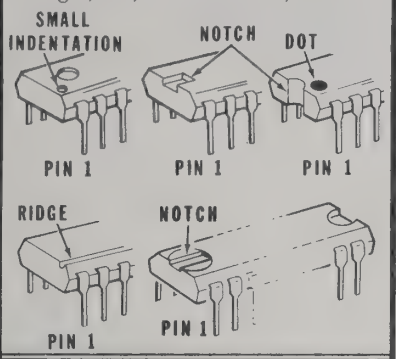
NOTE: This completes the assembly of this section of the circuit board. Be sure all connections are soldered and there are no solder bridges between adjacent foils. Jumper wire J in the lower left corner of this area will be installed later.

PICTORIAL 2-16



START

NOTE: The indexed (pin 1) end of in-line integrated circuits may be marked in a number of ways such as a notch, triangle, dot, the numeral 1, etc.

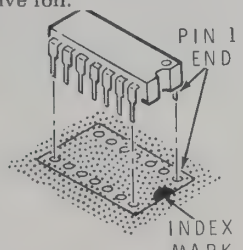


Before you install an IC, first be sure the pins are straight. Then lay it down on one of its rows of pins, as shown below at A, and roll it over until the pins are at right angles or are bent in slightly as shown at B. Repeat this process for the other row of pins.



Be sure you install each IC so its pin 1 end is toward the index mark on the circuit board and toward the 1 on this circuit board Pictorial.

() IC1: 3089 integrated circuit (#442-92). Position the pin 1 end of the IC over the index mark on the circuit board as shown. Then insert the pins into the circuit board and solder them to the foil. Do not solder the leads that do not have foil.



IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

PART NUMBER

CONTINUE

NOTE: Be sure to position the next three components down against the circuit board as shown.

(✓) L10: 39 μH choke (#45-608, silver-orange-white-black-gold).

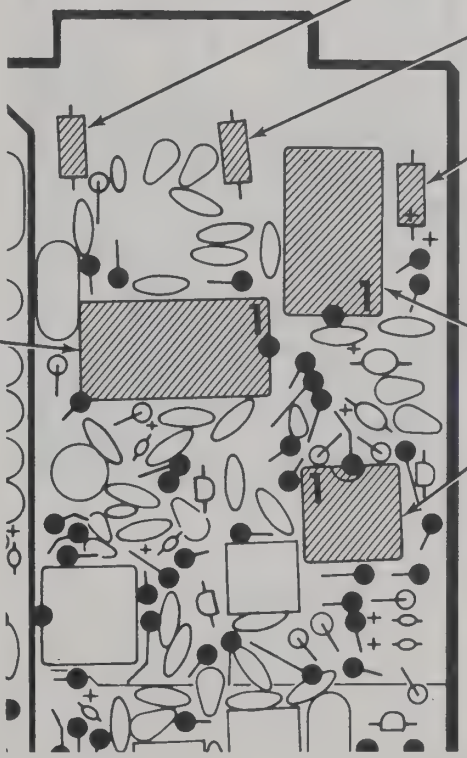
(✓) R29: 100 kΩ (brown-black-yellow).

(✓) C49: 33 μF tantalum. Be sure to position the positive (+) marked end of this capacitor toward the positive (+) mark on the circuit board.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

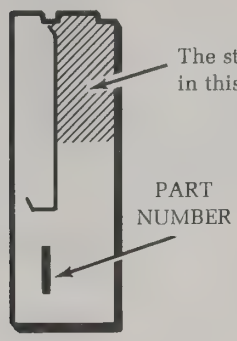
(✓) IC2: TBA820L integrated circuit (#442-610).

(✓) IC3: MC1458 integrated circuit (#442-21).



PICTORIAL 3-1

IDENTIFICATION DRAWING

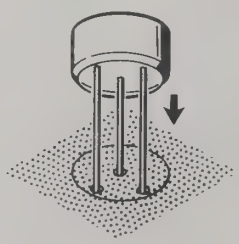


The steps performed in this Pictorial are in this area of the circuit board.

PART NUMBER

START

(✓) R88: 20 kΩ control (#10-1112). Match the leads on the control with the holes on the circuit board. Then push the control down against the circuit board and solder the leads to the foil. Cut off the excess lead lengths.





CONTINUE

NOTE: Be sure to position the banded ends of the following diodes as directed in the steps.

(✓) D8: 1N191 diode (#56-26, brown-white-brown). Position the **banded end down**.

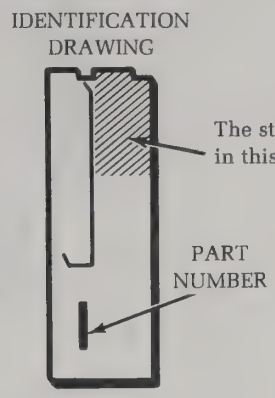
(✓) D7: 1N4149 diode (#56-56). Position the **banded end down**.

(✓) D5: 1N4149 diode (#56-56). Position the **banded end up**.

(✓) D10: 1N4149 diode (#56-56). Position the **banded end up**.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-2



START

- (✓) C38: .047 µF (473) ceramic.
- (✓) C32: .01 µF (103) ceramic.
- (✓) C35: .01 µF (103) ceramic.
- (✓) C34: .01 µF (103) ceramic.
- (✓) C39: .1 µF (104) ceramic.
- (✓) C36: .01 µF (103) ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) C86: .01 µF (103) ceramic.
- (✓) C85: .047 µF (473) ceramic.
- (✓) C84: 470 pF (471) ceramic.
- (✓) C80: .01 µF (103) ceramic.
- (✓) C24: .01 µF (103) ceramic.
- (✓) C22: 36 pF ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

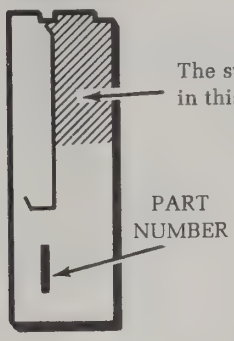


CONTINUE

- (✓) C41: .1 µF (104) ceramic.
- (✓) C28: .01 µF (103) ceramic.
- (✓) C43: .1 µF (104) ceramic.
- (✓) C31: .01 µF (103) ceramic.
- (✓) C44: .1 µF (104) ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) C42: 1500 pF (152) ceramic.
- (✓) C27: 150 pF (151) ceramic.
- (✓) C25: 150 pF (151) ceramic.
- (✓) C26: 470 pF (471) ceramic.
- (✓) C23: 2.2 pF ceramic.
- (✓) C29: .01 µF (103) ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-3

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

PART NUMBER

START

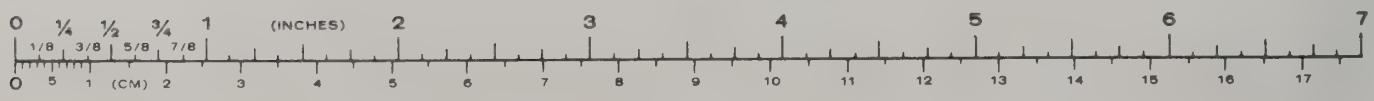
- () R24: 1000 Ω (brown-black-red).
- () R22: 3900 Ω (orange-white-red).
- () L11: 22 μH choke (#45-607, silver-red-red-black-gold).
- () R23: 3900 Ω (orange-white-red).
- () L9: 100 μH choke (#45-604, silver-brown-black-brown-silver).
- () R87: 3900 Ω (orange-white-red).
- () R86: 560 Ω (green-blue-brown). Use 1/4" of small sleeving on the lead coming from the top of this resistor.
- () R84: 220 kΩ (red-red-yellow).
- () Solder the leads to the foil and cut off the excess lead lengths.

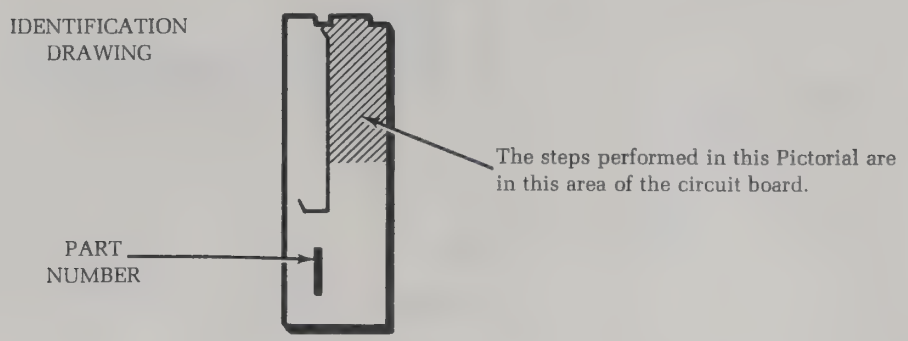


CONTINUE

- () R21: 1000 Ω (brown-black-red).
- () R26: 820 Ω (gray-red-brown).
- () R81: 22 kΩ (red-red-orange).
- () R19: 3300 Ω (orange-orange-red).
- () R83: 1800 Ω (brown-gray-red).
- () R78: 18 kΩ (brown-gray-orange).
- () R77: 10 kΩ (brown-black-orange).
- () R17: 4700 Ω (yellow-violet-red).
- () R18: 1000 Ω (brown-black-red).
- () Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-4





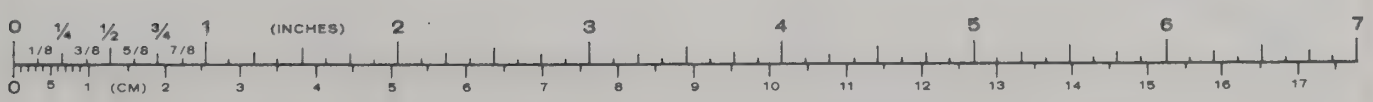
START

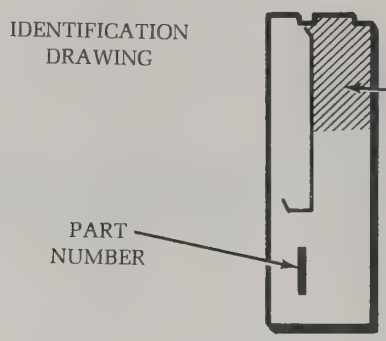
- (✓) R25: 18 kΩ (brown-gray-orange).
- (✓) R27: 10 kΩ (brown-black-orange).
- (✓) R39: 47 kΩ (yellow-violet-orange).
- (✓) R38: 47 kΩ (yellow-violet-orange).
- (✓) R41: 10 kΩ (brown-black-orange).
- (✓) R32: 10 kΩ (brown-black-orange).
- (✓) L8: 100 μH choke (#45-604, silver-brown-black-brown-silver).
- (✓) R16: 15 kΩ (brown-green-orange).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

- (✓) R31: 47 Ω (yellow-violet-black).
- (✓) R37: 6800 Ω (blue-gray-red).
- (✓) R33: 22 kΩ (red-red-orange). Use 1/4″ of small sleeving on the lead coming from the top of this resistor.
- (✓) R35: 10 kΩ (brown-black-orange).
- (✓) R36: 100 kΩ (brown-black-yellow).
- (✓) R34: 82 kΩ (gray-red-orange).
- (✓) R43: 10 kΩ (brown-black-orange).
- (✓) R42: 100 kΩ (brown-black-yellow).
- (✓) R44: 10 kΩ (brown-black-orange).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

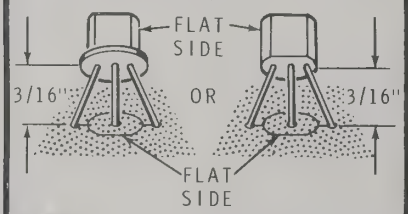
PICTORIAL 3-5





START

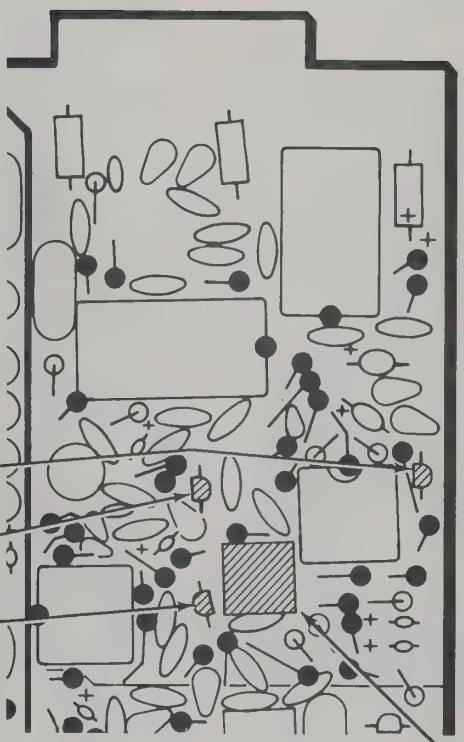
NOTE: Each of the following transistors may be one of the two types shown below. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder each lead to the foil and cut off the excess lead lengths.



() Q6: X29A829 transistor (#417-201).

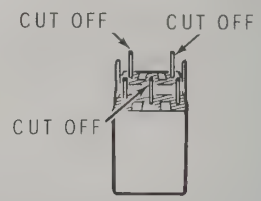
() Q5: 2N3393 transistor (#417-118).

() Q4: MPSH10 transistor (#417-887).



CONTINUE

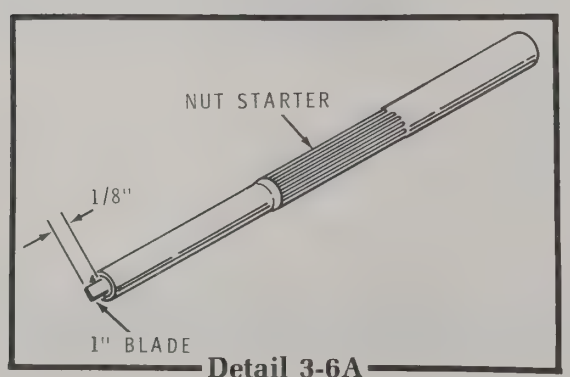
(✓) Locate the three IF transformers (#52-182). Then refer to the illustration below and cut off the three indicated lugs. Use one of these transformers in the next step. The other two transformers will be installed later.



() Refer to Detail 3-6A and use a pair of pliers to push the 1" blade into the smaller end of the nut starter until 1/8" remains exposed.

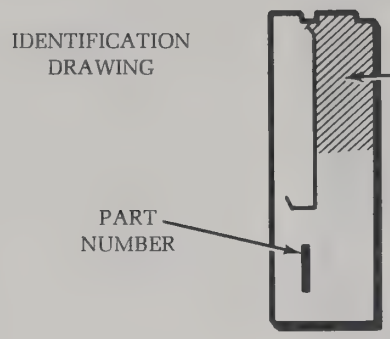
(✓) Use the blade end of the nut starter to loosen the slug in each of the IF transformers. Do not turn the slugs more than 1/4 turn either direction.

(✓) L7: Prepared IF transformer (#52-182). Match the lugs on the transformer to the holes in the circuit board and solder the two lugs and two tabs to the foil.



Detail 3-6A

PICTORIAL 3-6



START

(✓) R28/TP1: Cut one lead of a 4700 Ω (yellow-violet-red) resistor to 3/8". Form this lead into a loop; then crimp the loop tightly as shown. Insert the longer lead into the circuit board hole. Then solder the lead to the foil and cut off the excess lead length.



(✓) Cut a 3/8" length of small sleeving. Then slide the sleeving over the free lead of resistor R28 until the sleeving is against the circuit board.



(✓) C37: 1 μF tantalum. Position the positive (+) marked or red end of this capacitor **up**.

NOTE: Be sure to position the positive (+) or dot marked lead on the following capacitors toward the positive (+) mark on the circuit board.

Install two 68 μF tantalum capacitors at the following locations. Be careful you do not use the smaller .68 μF capacitors.

(✓) C46.

(✓) C45.

Install four .68 μF tantalum capacitors at:

(✓) C33.

(✓) C82.

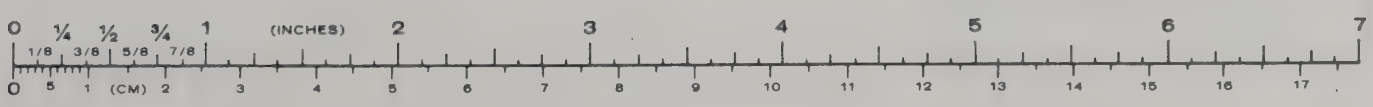
(✓) C47.

(✓) C48.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: This completes the assembly of this section of the circuit board. Be sure all connections are soldered and there are no solder bridges between adjacent foils.

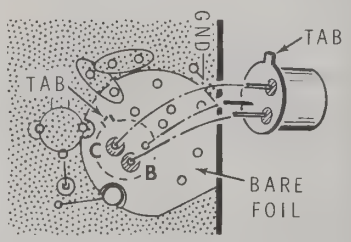
PICTORIAL 3-7



START

() Q17: MRF237 or SD1127 transistor (#417-912). Install this transistor as follows: NOTE: The outline for this transistor is NOT shown on the circuit board.

1. Hold the transistor with the tab positioned as shown below.
2. Carefully study your circuit board and the illustration and locate the three holes for this transistor.
3. Insert the leads of the transistor in the proper circuit board holes. Then push the transistor down tight against the circuit board.
4. Make sure the transistor is in the correct holes and the tab is positioned as shown on the Pictorial. Then solder the leads to the foil and cut off the excess lead lenghts.



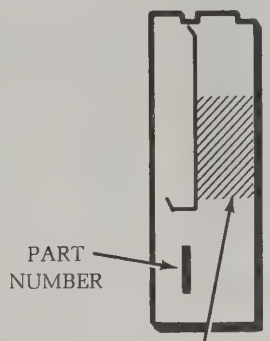
The following tests are to make sure no solder bridges exist around transistor Q17.

() Set your ohmmeter to the R × 1 range. Then touch the ohmmeter leads together and zero the meter.

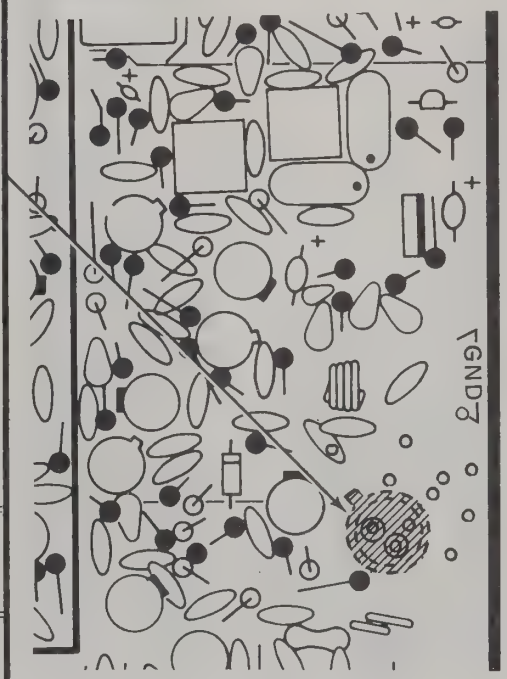
() Refer to the illustration above and connect either ohmmeter lead to the bare foil (GND) on the circuit board.

() Connect the other ohmmeter lead first to the base (B) lead of transistor Q17, then to the collector (C) lead. In both cases the ohmmeter should indicate 10 ohms or greater, indicating that no short circuit exists. If you get a lower reading: reheat the connection to the B and C leads until the short circuit disapears.

IDENTIFICATION DRAWING



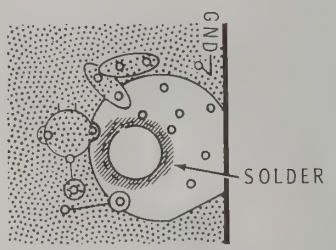
The steps performed in this Pictorial are in this area of the circuit board.



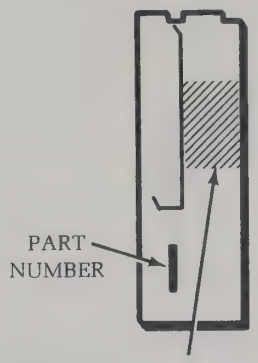
PICTORIAL 3-8

CONTINUE

() Check the installation of transistor Q17 once more to make sure it is correctly installed. Then run a bead of solder all the way around the transistor and solder the flange on the transistor to the foil on top of the circuit board as shown.



IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

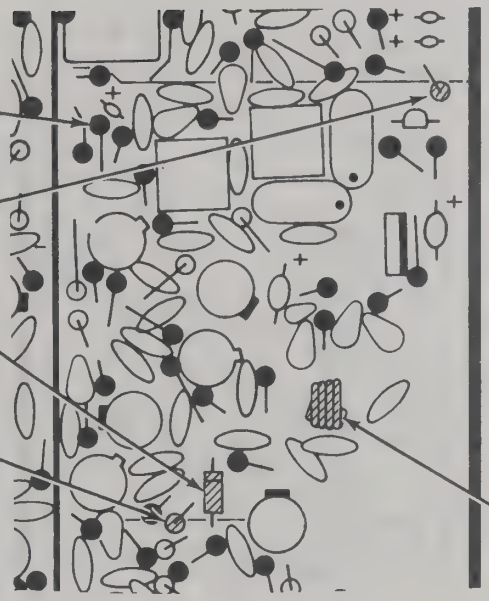
(✓) D14: VRS-5A zener diode (#56-54). Position the **banded end down**.

(✓) D12: 1N4149 diode (#56-56). Position the **banded end up**.

(✓) D11: BA244 diode (#56-646, red-yellow-yellow). Position the red band on this diode toward the band mark on the circuit board.

(✓) D9: 1N4149 diode (#56-56). Position the **banded end up**.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

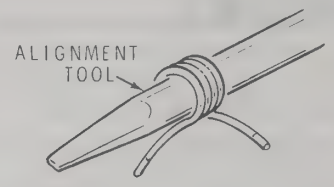


PICTORIAL 3-9

CONTINUE

(✓) Cut a 2-3/4" length of magnet wire and scrape 3/8" of insulation from each wire end. Then apply a small amount of solder to the bare wire ends.

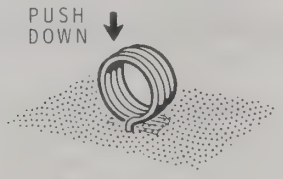
(✓) Wind the 2-3/4" length of magnet wire into a closewound 4-turn coil as shown. Do not wind the soldered-covered lead ends.

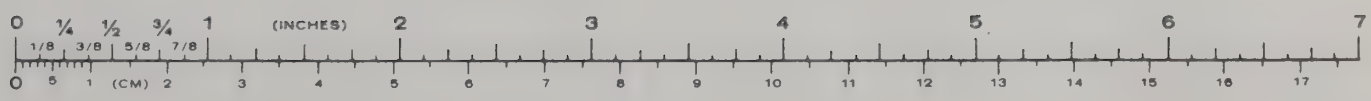


(✓) Form the two coil leads so they point straight down as shown.

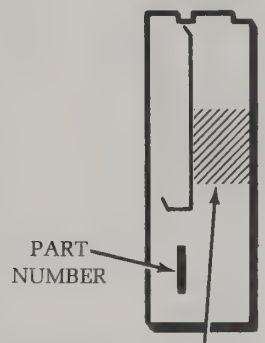


(✓) L41: Mount the prepared coil on the circuit board as shown. Push the coil tightly down against the circuit board and solder the leads to the foil. When the connections cool, use a piece of insulator paper to spread the turns of the coil slightly apart.





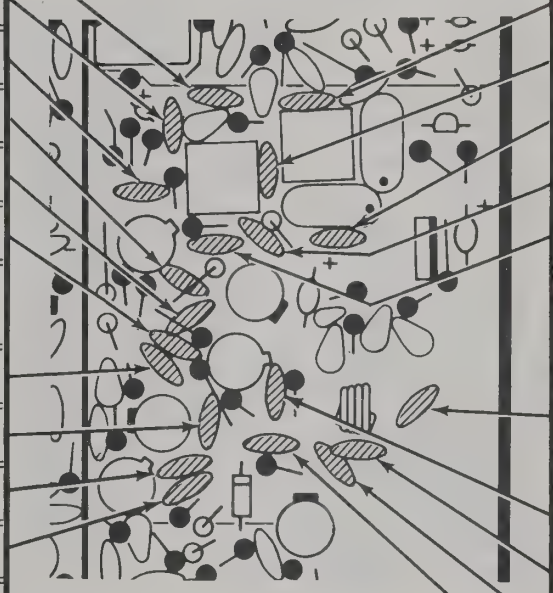
IDENTIFICATION
DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

- [] C79: .1 μF (104) ceramic.
- [] C81: 470 pF (471) ceramic.
- [] C18: 47 pF ceramic.
- [] C15: 6.8 pF ceramic.
- [] C13: 6.8 pF ceramic.
- [] C7: 470 pF (471) ceramic.
- [] Solder the leads to the foil and cut off the excess lead lengths.
- [] C6: 470 pF (471) ceramic.
- [] C9: 6.8 pF ceramic.
- [] C8: 5 pF ceramic.
- [] C5: 470 pF (471) ceramic.
- [] Solder the leads to the foil and cut off the excess lead lengths.

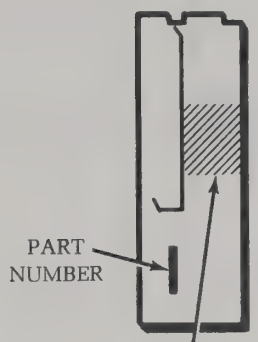


CONTINUE

- [] C21: 47 pF ceramic.
- [] C16: .01 μF (103) ceramic.
- [] C19: 2.2 pF ceramic.
- [] C14: 470 pF (471) ceramic.
- [] C17: .01 μF (103) ceramic.
- [] Solder the leads to the foil and cut off the excess lead lengths.
- [] C126: 22 pF ceramic. Be careful you don't use the hole near the center of the outline on the circuit board.
- [] C12: 470 pF (471) ceramic.
- [] C125: 6.8 pF ceramic.
- [] C124: 22 pF ceramic.
- [] C123: 470 pF (471) ceramic.
- [] Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-10

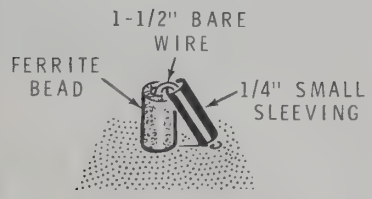
IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

- () R85: 330 Ω (orange-orange-brown).
- () R12: 47 kΩ (yellow-violet-orange).
- () R1: 33 kΩ (orange-orange-orange).
- () R2: 47 kΩ (yellow-violet-orange).
- () Solder the leads to the foil and cut off the excess lead lengths.



Detail 3-11A



PICTORIAL 3-11

CONTINUE

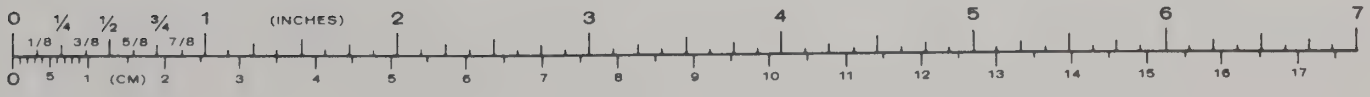
In the following step choose the resistor which best fits your own situation. If you have a:

Soft voice, use a 220 kΩ (red-red-yellow) resistor.

Normal level voice, use a 120 kΩ (brown-red-yellow) resistor.

Loud voice or talk with the microphone close to your mouth, use a 68 kΩ (blue-gray-orange) resistor.

- () Selected resistor.
- () R74: 4700 Ω (yellow-violet-red).
- () R82: 4700 Ω (yellow-violet-red).
- () R15: 6800 Ω (blue-gray-red).
- () R14: 100 Ω (brown-black-brown).
- () Remove the insulation from a 1-1/2" white wire. Use this wire to install the ferrite bead in the next step.
- () Ferrite bead. Be sure to use 1/4" of small sleeving. See Detail 3-11A.
- () Solder the leads to the foil and cut off the excess lead lengths.
- () R11: 47 kΩ (yellow-violet-orange).
- () R6: 100 kΩ (brown-black-yellow). Use 1/4" of small sleeving on the lead coming from the top of this resistor.
- () R7: 33 kΩ (orange-orange-orange).
- () R8: 47 kΩ (yellow-violet-orange).
- () R3: 100 kΩ (brown-black-yellow).
- () R4: 220 Ω (red-red-brown).
- () Solder the leads to the foil and cut off the excess lead lengths.

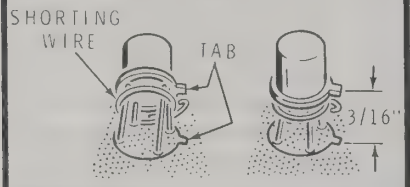




The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: Install the following transistors in the manner shown. First, line up the tab with the tab outline on the circuit board. Insert the transistor leads into the corresponding holes on the circuit board. Solder each lead to the foil and cut off the excess lead lengths. Then remove the shorting wire from the transistor leads.



Install three 40673 transistors (#417-274) at:

() Q3.

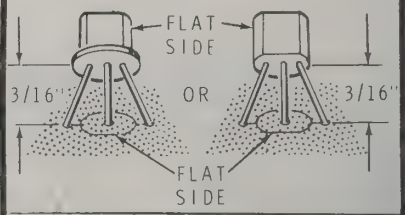
() Q2.

() Q1.



CONTINUE

NOTE: Each of the following transistors may be one of the two types shown below. First line up the flat on the transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder each lead to the foil and cut off the excess lead lengths.



() Q7: X29A829 transistor (#417-201).

() R45: 10 kΩ (brown-black-orange).

() R46: 10 Ω, 1/2-watt (brown-black-black).

() L5: 100 μH choke (#45-604, silver-brown-black-brown-silver).

() R47: 1000 Ω (brown-black-red).

() R48: 270 Ω (red-violet-brown).

() R76: 4700 Ω (yellow-violet-red).

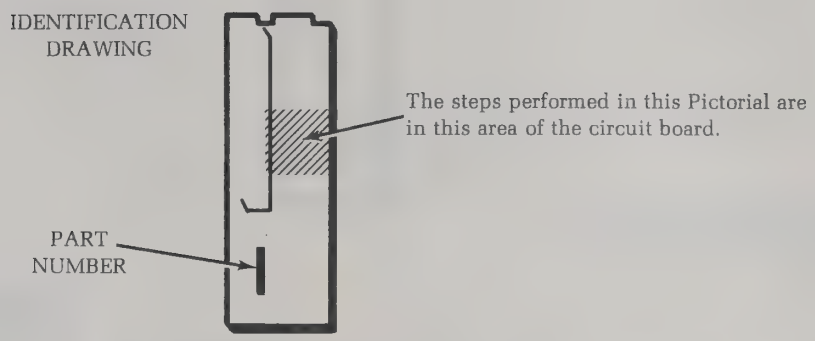
() R75: 4700 Ω (yellow-violet-red).

() R9: 220 Ω (red-red-brown).

() R125: 1000 Ω (brown-black-red).

() Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-12



START

NOTE: Use the two remaining IF transformers which you prepared earlier in the next two steps. Solder the lugs to the foil as you install each transformer.

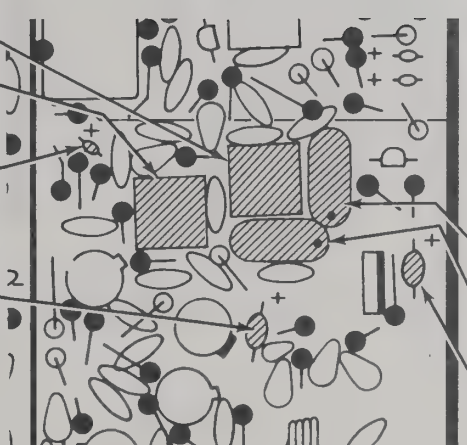
() L4: IF transformer (#52-182).

() L6: IF transformer (#52-182).

() C83: .68 μF tantalum. Be sure to position the positive (+) or dot marked capacitor lead toward the positive (+) mark on the circuit board.

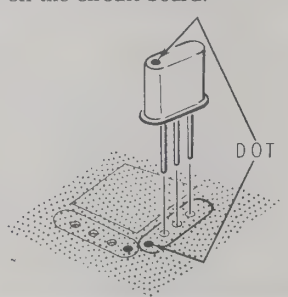
() C11: 10 μF tantalum.

() Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

NOTE: Use the matched set of 10.7 MHz filters (#404-600) in the next two steps. Be sure to install each filter so the dot marked lead is toward the dot mark on the circuit board.



() FL2: 10.7 MHz filter (1/2 #404-600).

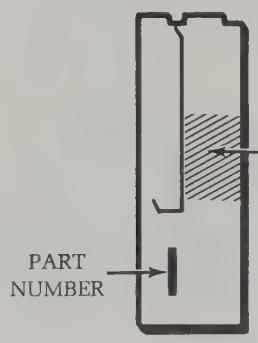
() FL1: 10.7 MHz filter (1/2 #404-600).

() C51: 10 μF tantalum.

() Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-13

IDENTIFICATION DRAWING



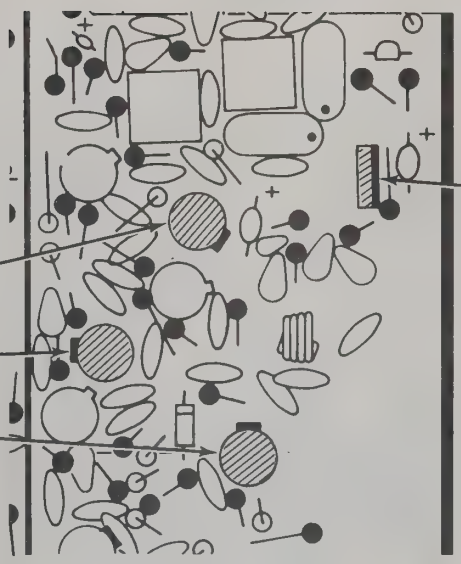
START

NOTE: When you install the following coils, be sure to position the tab on each coil toward the tab mark on the circuit board. Solder the leads to the foil and cut off the excess lead lengths as you install each coil.

() L3: .2 μH coil (orange, #40-1782).

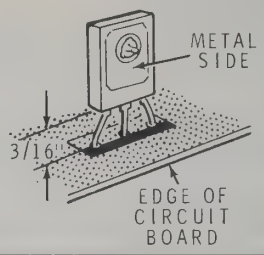
() L2: .14 μH coil (yellow, #40-1783).

() L39: .11 μH coil (red-, #40-1784).



CONTINUE

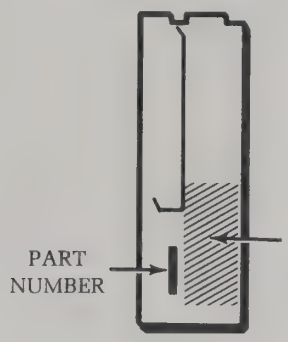
() Q8: MJE171 transistor (#417-819). Position the metal side of this transistor toward the edge of the circuit board as shown. Solder the leads to the foil and cut off the excess lead lengths.



NOTE: This completes the assembly of this section of the circuit board. Be sure all connections are soldered and there are no solder bridges between adjacent foils.

PICTORIAL 3-14

IDENTIFICATION DRAWING



START

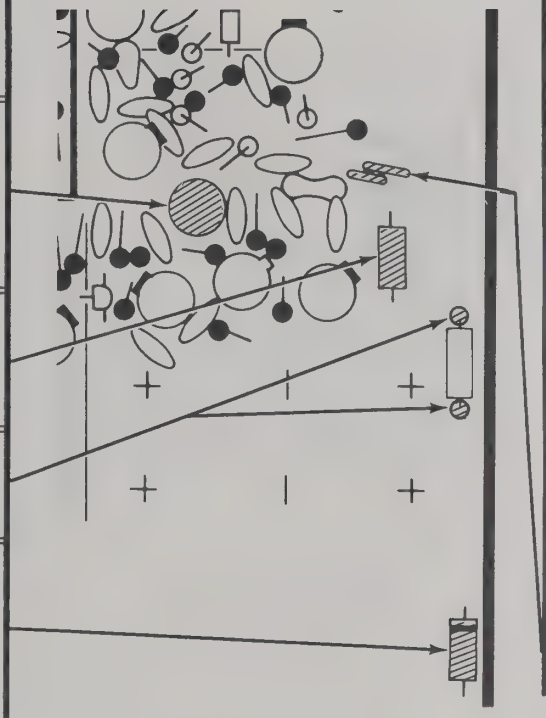
NOTE: Solder the following parts to the foil as you install them and cut off the excess lead lengths.

(✓) R114: 1000 Ω (1 kΩ) control (#10-1113). Match the leads on the control with the holes in the circuit board. Then push the control down against the circuit board.

(✓) R122: 56 Ω (green-blue-black). Position this resistor down against the circuit board as shown.

(✓) Two crystal socket pins. Do not cut off these pins after you solder them to the foil.

(✓) D13: 1N2071 diode (#57-27). Be sure to position the banded end of this diode toward the band mark on the circuit board. Mount this diode down against the circuit board as shown.



CONTINUE

(✓) Prepare a 1-turn coil as follows:

1. Cut a 1-1/4" length of **bare wire**.
2. Wind the 1-1/4" bare wire into a closewound (but not touching) 1-turn coil as shown.



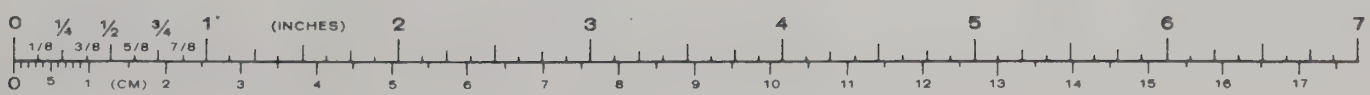
3. Form the two coil leads so they point straight down as shown in Detail 3-15A. Your coil should be the same size and shape.

(✓) L38: Install the prepared coil in the circuit board as shown. Push the coil down close to the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.

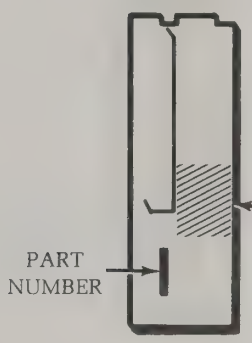
PICTORIAL 3-15



Detail 3-15A

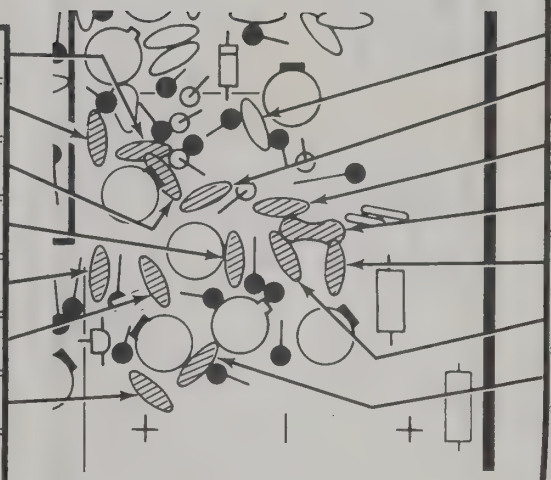


IDENTIFICATION DRAWING



START

- () C1: 10 pF ceramic.
- () C4: 3.3 pF ceramic.
- () C2: 47 pF ceramic.
- () C114: 470 pF (471) ceramic.
- () C108: 470 pF (471) ceramic.
- () C109: 470 pF (471) ceramic.
- () C111: 20 pF ceramic.
- () Solder the leads to the foil and cut off the excess lead lengths.

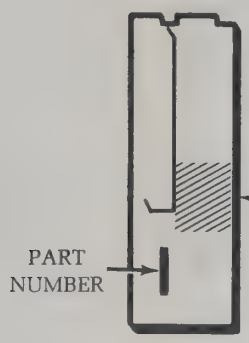


CONTINUE

- NOTE: Do not install a capacitor at this location.
- () C119: .1 μF (104) ceramic.
- () C116: 470 pF (471) ceramic.
- () C117: 82 pF **mica**.
- () C115: 6.8 pF ceramic.
- () C112: .01 μF (103) ceramic.
- () C113: 10 pF ceramic.
- () Solder the leads to the foil and cut off the excess lead lengths.

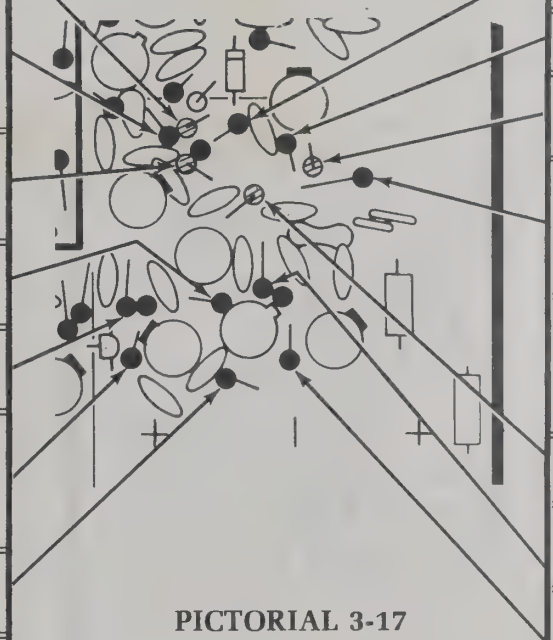
PICTORIAL 3-16

IDENTIFICATION DRAWING



START

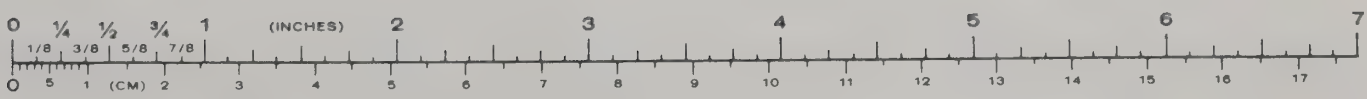
- () D6: 1N4149 diode (#56-56). Position the **banded end up**.
- () R5: 2200 Ω (red-red-red). Use 1/4" of small sleeving on the lead coming from the top of this resistor.
- () D18: 1N191 diode (#56-26, brown-white-brown). Position the **banded end down**.
- () R115: 10 kΩ (brown-black-orange).
- () R113: 100 Ω (brown-black-brown).
- () R112: 3300 Ω (orange-orange-red). Use 1/4" of small sleeving on the lead coming from the top of the resistor.
- () R116: 470 Ω (yellow-violet-brown).
- () Solder the leads to the foil and cut off the excess lead lengths.



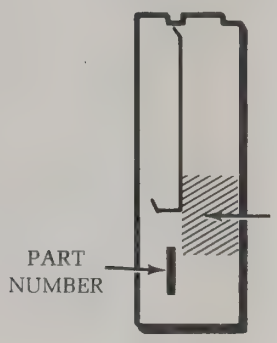
PICTORIAL 3-17

CONTINUE

- () C122: .47 pF phenolic (yellow-violet-gray-gold) **capacitor**.
- () R123: 1000 Ω (brown-black-red).
- () L40: .10 μH choke (#45-605, silver-gold-brown-black-silver).
- () R121: 2200 Ω (red-red-red). Use 1/4" of small sleeving on the lead coming from the top of this resistor.
- () Remove the insulation from a 1-1/2" length of white wire. Use this wire to install the ferrite bead in the next step.
- () Ferrite bead.
- () R118: 47 Ω (yellow-violet-black).
- () R119: 1500 Ω (brown-green-red). Use 1/4" of sleeving on the lead coming from the top of this resistor.
- () Solder the leads to the foil and cut off the excess lead lengths.

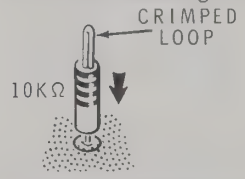


IDENTIFICATION DRAWING



START

() R124/TP8: Cut one lead of a 10 kΩ (brown-black-orange) resistor to 3/8". Form this lead into a loop; then crimp the loop tightly as shown. Insert the longer lead into the circuit board hole. Then solder the lead to the foil and cut off the excess lead lengths.

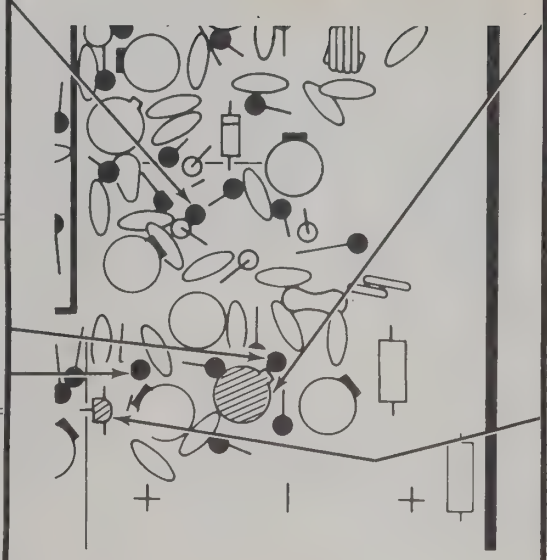


Similarly install 10 kΩ (brown-black-orange) resistors at:

() R117/TP7.

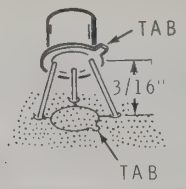
() R111/TP6.

() Cut three 3/8" lengths of small sleeving. Then slide a length of sleeving over resistors R124, R117, and R111 until the sleeving is against the circuit board.

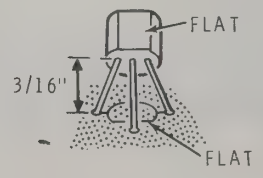


CONTINUE

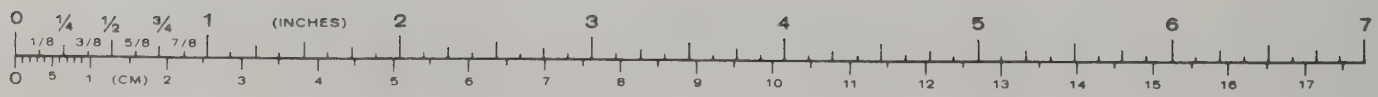
() Q16: 2N2369 transistor (#417-154). Line up the tab on this transistor with the outline of the tab on the circuit board. Then insert the leads into the corresponding holes. Solder the leads to the foil and cut off the excess lead lengths.



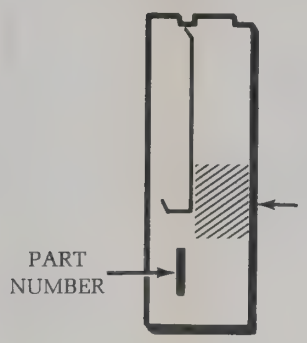
() Q15: 2N5770 transistor (#417-934). Line up the flat on this transistor with the outline of the flat on the circuit board. Insert the transistor leads into the corresponding holes. Solder the leads to the foil and cut off the excess lengths.



PICTORIAL 3-18



IDENTIFICATION DRAWING



START

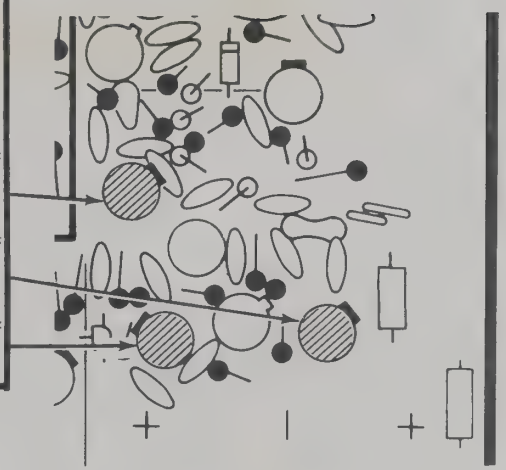
NOTE: Be sure to line up the tab on each of the following coils with the outline of the tab on the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.

If the tab on the coil interferes with other parts, cut the tab off.

() L1: .14 μH coil (yellow, #40-1783).

() L37: .14 μH coil (yellow, #40-1783).

() L36: .11 μH coil (red, #40-1784).



PICTORIAL 3-19

CONTINUE

CIRCUIT BOARD CHECKOUT

Carefully inspect the foil side of the circuit board for the following most commonly made errors.

() Unsoldered connections.

() "Poor" solder connections.

() Solder bridges between foil patterns.

() Protruding leads which could touch together or the chassis when the circuit board is installed later.

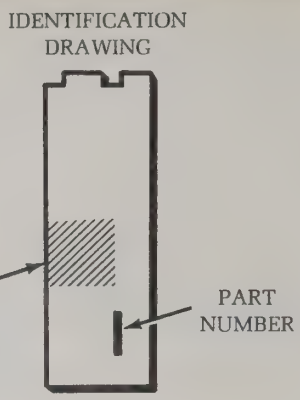
Refer to the illustrations where the parts were installed as you make the following visual checks.

() Transistors for proper **type** and **installation**.

() Integrated circuits for the proper **type** and **installation**.

() Tantalum capacitors for the correct position of the positive (+) or dot marked lead.

() Diodes for the proper **type** and **installation**.

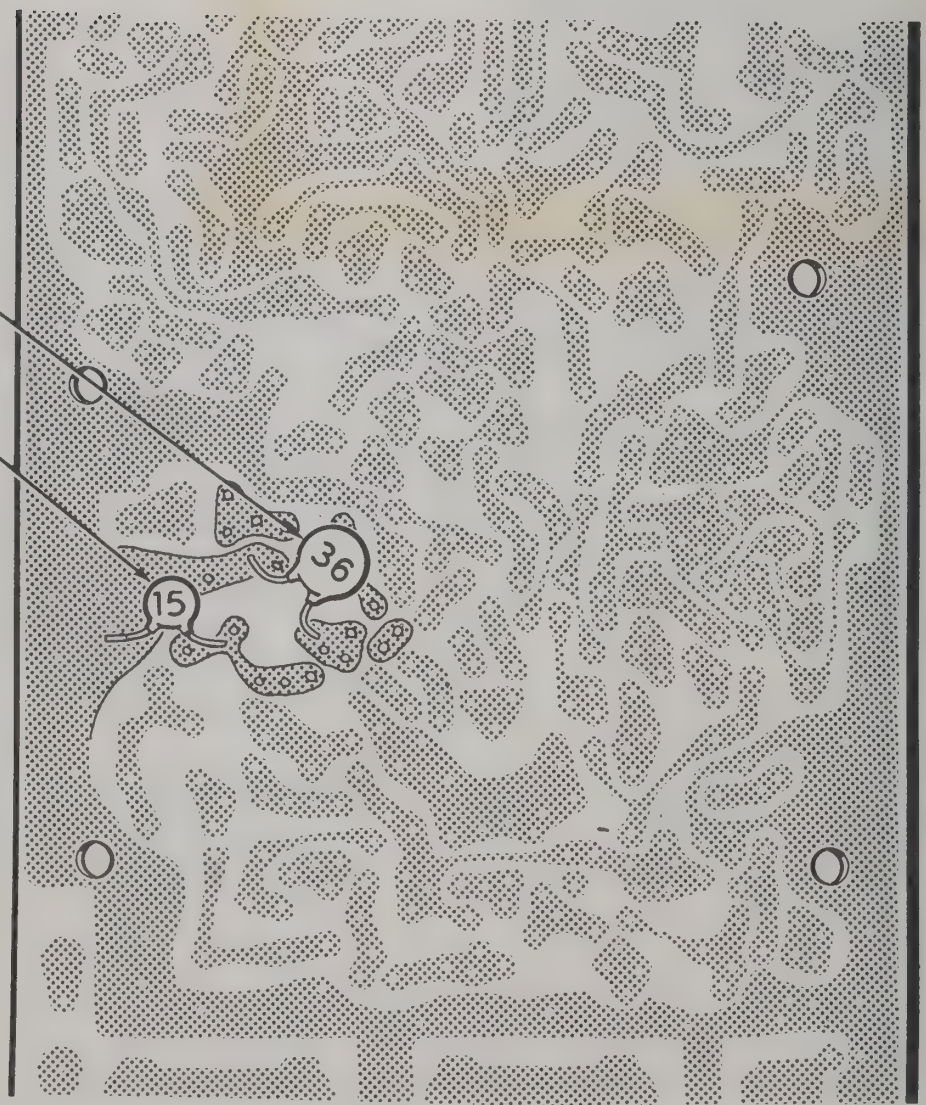


START

() Position the circuit board **foil-side-up** as shown in the Identification Drawing.

() C128: Cut both leads of a 36 pF ceramic capacitor to 1/8". Then solder the capacitor between the two indicated foil pads.

() C127: Cut both leads of a 15 pF ceramic capacitor to 1/8". Then solder the capacitor between the two indicated foil pads.



PICTORIAL 3-20

Refer to Pictorial 3-21 (Illustration Booklet, Page 5) for the following steps.

() Cut an 8" length of 8-wire cable. Set this 8" length aside until it is called for in a step.

() Separate the remaining length of 8-wire cable into eight individual wires. Use these individual wires when a step directs you to prepare stranded wire.

NOTE: When a step directs you to prepare stranded wires, as in the next step, first cut the wire to the indicated length and remove 1/4" of insulation from each end. Twist together the strands at each end and melt a small amount of solder on the wire ends to hold the fine strands together. The wires are listed in the order in which you will use them.

() Prepare the following stranded wires:

2-1/2" orange	4" red
2-1/4" gray	4" gray
3-3/4" orange	

NOTE: Read the following steps carefully when you connect each wire to the circuit board. Also be sure to route each wire as shown in the Pictorial.

() Connect the 2-1/2" orange wire from either hole ORG near transistor Q8 (S-1) to either hole ORG near resistor R85 (S-1).

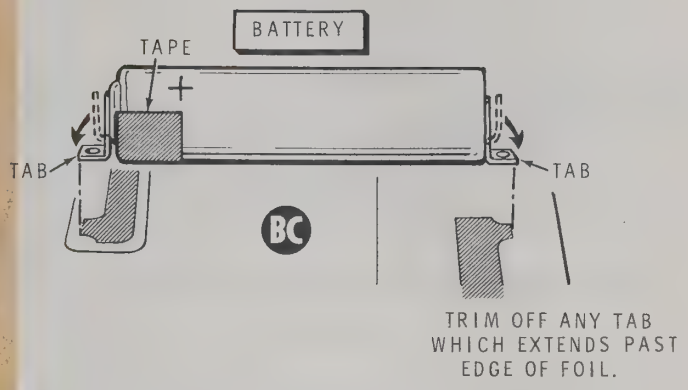
() Connect the 2-1/4" gray wire from hole B near resistor R3 (S-1) to hole B near resistor R5 (S-1).

() Connect the 3-3/4" orange wire from the remaining hole ORG near resistor R85 (S-1) to hole ORG near capacitor C104 (S-1).

() Connect the 4" red wire from hole RED closest to resistor R27 (S-1) to hole RED near resistor R85 (S-1).

() Connect the 4" gray wire from hole GRY near choke L9 (S-1) to hole GRY near capacitor C11 (S-1).

() Bend the bare wires at AA, AB, and AC as shown so they hold the stranded wires against the lateral shield.



Detail 3-21A

() Refer to Detail 3-21A and mount a battery to the circuit board at BC as follows:

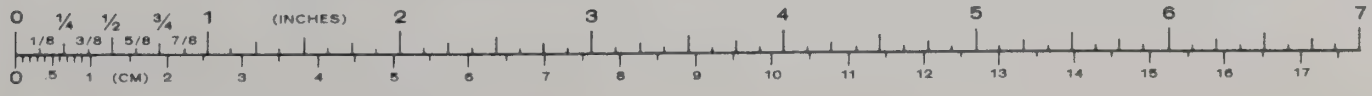
1. Form the tab on each end of the battery so it is at a right angle to the end of the battery and is flush with the side of the battery. Place the battery on a flat surface to check this. When you have the tab correctly formed, the end of each tab should be flat against the surface.

2. Cut a 1" length of tape. Then press the tape onto the positive (+) end of the battery (see the inset drawing on the Pictorial) as shown. When you have it properly installed, the tape should extend just past the end of the battery case.

3. Position the battery against the circuit board at BC as shown in the Pictorial. NOTE: Be sure to match the positive (+) end of the battery with the positive (+) mark on the circuit board (see the inset drawing on the Pictorial.) **Be sure to trim off any excess tab which extends past the edge of the foil area.**

4. Hold the battery in place against the circuit board (again be sure to observe the battery polarity). Then carefully solder the tabs to the foil on top of the circuit board.

5. Check the battery to make sure it is still flat against the circuit board. Reheat the connections and reposition the battery as necessary.



NOTE: Be sure to install the batteries, in the next steps, in the sequence given.

() Use the same procedure to mount batteries at BB, BA BD, and BE. Be sure to observe the correct polarity as you install each battery. Also be sure to install a 1" length of tape on the positive (+) end of each battery.

Refer to Pictorial 3-22 for the following steps.

() Position the circuit board assembly foil-side-up as shown in the Pictorial.

() Prepare a 3" orange stranded wire. Remove only 1/8" of insulation from the ends of this wire.

NOTE: When you connect a wire to the foil side of the circuit board, as in the next step, be sure to position the wire as shown in the Pictorial. Then position the insulation near each end of the wire 1/16" above the foil side of the circuit board so you can solder the connections (see the inset drawing on the Pictorial).

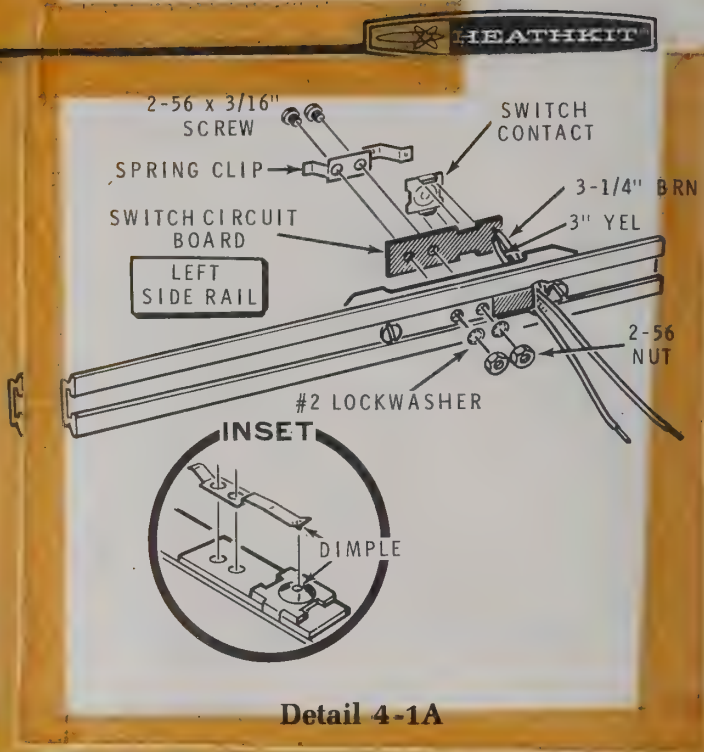
() Connect the 3" orange wire between the two indicated foil pads. Solder each connection.

() Position the foil shield on the circuit board in the area shown. Make sure the shield is perpendicular to the circuit board and against the crystal socket pins. Then run a bead of solder along the bottom edge of the shield to secure it to the foil.

NOTE: Be sure to install the batteries, in the next step, in the sequence given.

() Use the same procedure as you did earlier to install batteries at BH, BG, BF, BJ, and BK. Be sure to observe the correct polarity as you install each battery. Also be sure to install a 1" length of tape on the positive (+) end of each battery.

() Set the circuit board aside temporaily.



Detail 4-1A

Refer to Pictorial 4-1 (Illustration Booklet, Page 6) for the following steps.

() Prepare a 3" yellow stranded wire and a 3-1/4" brown stranded wire. Remove only 1/8" of insulation from the ends of these wires.

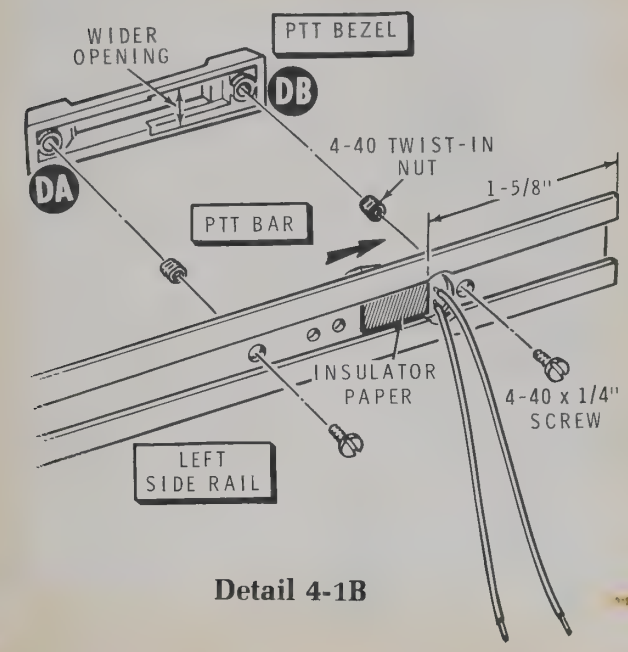
() Refer to Detail 4-1A and prepare pushbutton switch assembly SW204 as follows:

1. Connect one end of the 3 yellow wire to SW204 hole 1 (S-1). The other end of this wire will be connecteed later.

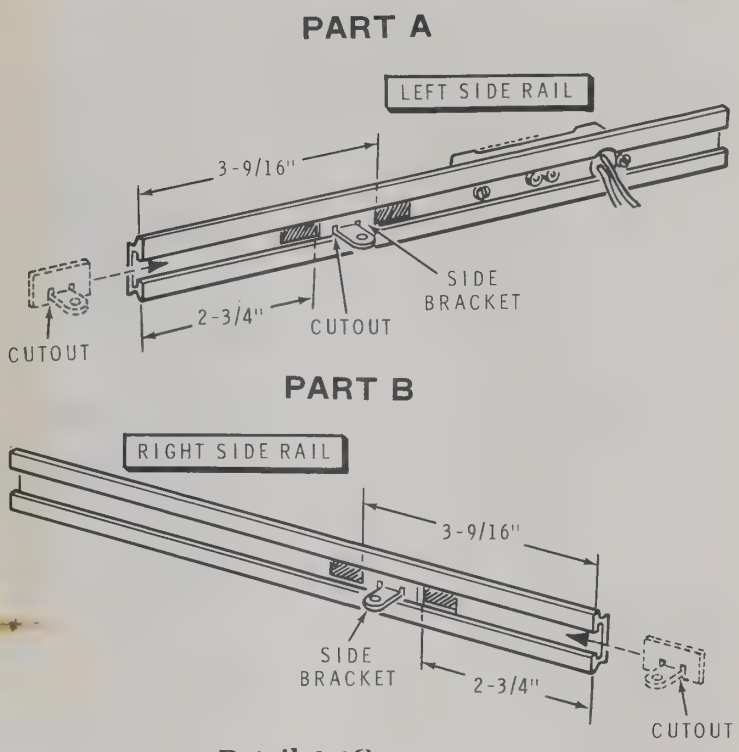
2. Connect one end of the 3-1/4" brown wire to SW204 hole 2 (S-1). The other end of this wire will be connected later.

() SW204: Refer again to Detail 4-1A and mount the pushbutton switch circuit board to the left side rail. Use two 2-56 × 3/16" screws, a spring clip, a switch spring, two #2 lockwashers, and two 2-56 nuts. Be sure the brown and yellow wires pass through the larger hole in the side rail as shown.

() Refer to Detail 4-1B and use the hex spacer and 4-40 nut (saved from the charger assembly) to install 4-40 twist-in nuts at DA and DB in the PTT bezel. Use the same procedure as you did for the charger case and turn the twist-in nuts all the way into the bezel.



Detail 4-1B



Detail 4-1C

() Cut eight 1/4" × 1/2" pieces of insulator paper.

() Carefully peel the backing paper from a 1/4" × 1/2" insulator paper. Then press the insulator paper into the channel in the left side rail 3-9/16" from the end of the rail as shown in Detail 4-1C Part A.

() Carefully peel the backing paper from a 1/4" × 1/2" insulator paper. Then press this insulator directly on top of the insulator you just installed.

() Refer again to Detail 4-1C Part A and slide a side bracket into the channel in the left side rail as shown. Be sure to position the bracket so the cutout is toward the indicated edge of the rail.

() Carefully peel the backing paper from a 1/4" × 1/2" insulator paper. Then press the insulator paper into the channel in the left side rail 2-3/4" from the end of the rail as shown in the Pictorial.

() Carefully peel the backing paper from a 1/4" × 1/2" insulator paper. Then press this insulator directly on top of the insulator you just installed.

() Set the left side rail aside temporarily.

() Carefully peel the backing paper from a 1/4" × 1/2" insulator paper. Then press the insulator paper into the channel in the right side rail 3-9/16" from the end of the rail as shown in Part B of the Detail.

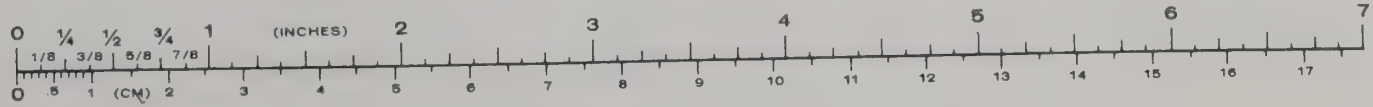
() Carefully peel the backing paper from a 1/4" × 1/2" insulator paper. Then press this insulator directly on top of the insulator you just installed.

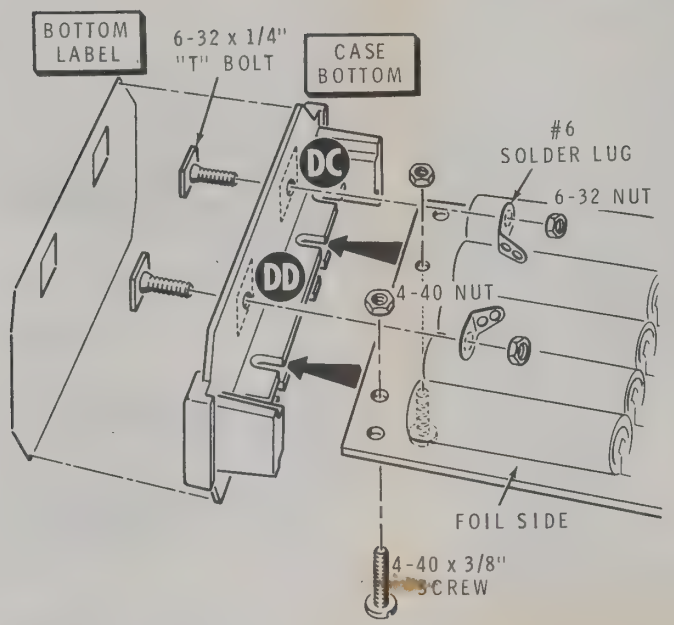
() Slide a side bracket into the channel in the right side rail so the cutout in the bracket is positioned as shown in Detail 4-1C Part B.

() Carefully peel the backing paper from 1/4" × 1/2" insulator paper. Then press the insulator paper into the channel in the right side rail 2-3/4" from the end of the rail as shown in the Pictorial.

() Carefully peel the backing paper from the remaining 1/4" × 1/2" insulator paper. Then press this insulator directly on top of the insulator you just installed.

() Set the right side rail aside temporarily.





Detail 4-1D

NOTE: Use the nut starter supplied with this kit (wherever possible) to hold and start 4-40 and 6-32 nuts on screws.

() Refer to Detail 4-1D and mount the case bottom onto the bottom edge of the circuit board as shown. Be sure holes DC and DD are toward the foil side of the circuit board. Use two 4-40 × 3/8" screws and two 4-40 nuts as shown. Push the circuit board down between the mounting tabs on the case bottom as far as possible before you tighten the hardware.

() Refer again to Detail 4-1D and mount a #6 solder lug at DC on the case bottom. Use a 6-32 × 1/4" "T" bolt and a 6-32 nut. Be sure the square head on the bolt goes into the square recess in the case bottom. Position the solder lug as shown in the Pictorial before you tighten the nut.

() Similarly, mount a #6 solder lug at DD on the case bottom. Position the solder lug as shown in the Pictorial.

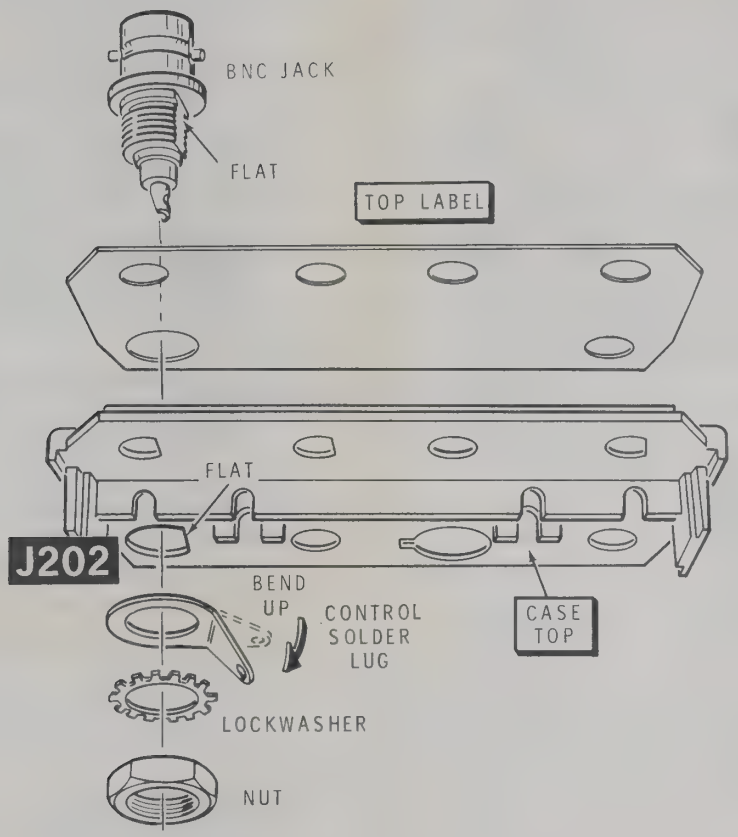
() Carefully peel the backing paper from the bottom label. Then line up the square holes in the label with the square heads on the "T" bolts on the case bottom and press the label in place.

() Prepare a 2-1/4" red stranded wire and a 2-3/4" brown stranded wire.

NOTE: The circuit board holes called out in the next two steps are printed on the component side of the circuit board. Solder each wire to the indicated hole on the **foil side** of the circuit board. Be sure to route each wire as shown in Pictorial 4-1.

() Connect the 2-1/4" red wire from circuit board hole BB (S-1) to solder lug DC (S-1).

() Connect the 2-3/4" brown wire from circuit board hole GND (S-1) to solder lug DD (S-1).



Detail 4-1E

NOTE: When you perform the next step, be sure to use the correct label. Determine which label you should install from the following information:

1. If you do not have either the Microphone or the Tone/Burst accessories, use the top label supplied with this kit.

2. If you have only the Push-To-Talk Microphone accessory, use label #390-1501 supplied with that kit.

3. If you have only the Tone/Burst Accessory, use label #390-1500 supplied with that kit.

4. If you have both of the accessories mentioned above, use label #390-1502 supplied with either of the accessory kits.

(✓) Install the proper label onto the case top as follows:

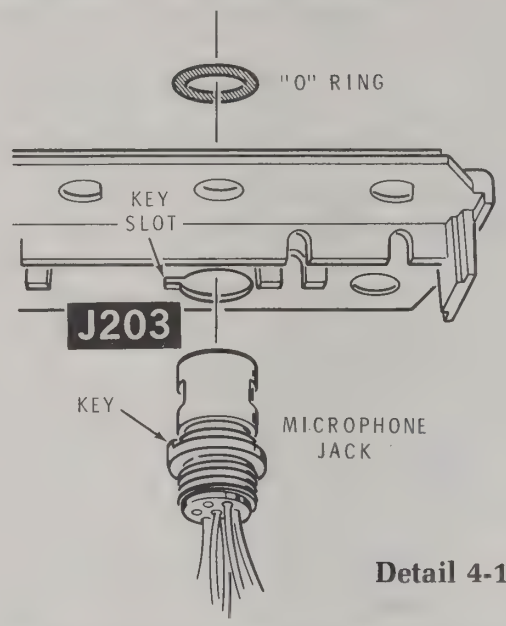
1. Carefully peel the backing paper from the top label.

2. Line up the holes in the label with the holes in the case top as shown in Detail 4-1E. Then press the label in place on the case top.

NOTE: The BNC jack which you will install in the next step, is a tight fit. Some force will be required to install this jack.

(✓) J202: Refer to Detail 4-1E and mount the BNC jack at J202 on the case top. Match the flat on the bushing of the jack with the flat in the hole. Use a control solder lug and the lockwasher and nut supplied with the jack. Then bend the control solder lug away from the case top as shown.

NOTE: Perform the next two boxed-in steps **only** if you have the microphone accessory at this time.



Detail 4-1F

() Remove only the microphone jack and the "O" ring from the microphone accessory kit. Do not intermix any of the other accessory parts with the Transceiver parts.

() J203: Refer to Detail 4-1F and mount the microphone jack at J203 in the case top. Be sure to line up the key on the jack with the key slot in the case top. Then secure the jack with the "O" ring.

() Refer to Detail 4-1G and assemble the frame for the Transceiver case as follows:

1. Slide the right side rail onto the indicated flange of the case bottom as shown. Be sure the side bracket is on the foil side of the circuit board as shown. Then push the side rail down onto the flange as far as possible.

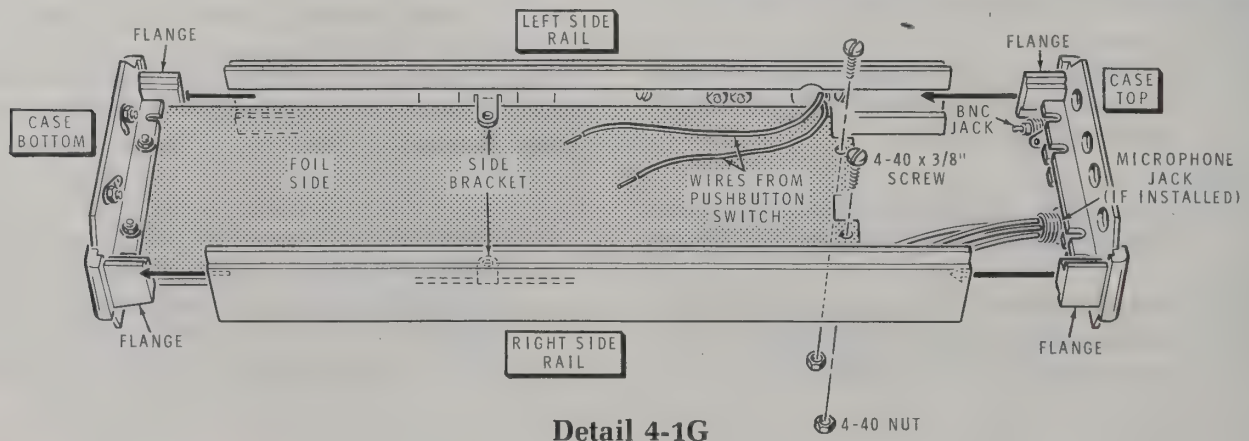
2. Similarly, slide the left side rail onto the indicated flange on the case bottom as shown. Again be sure the side bracket is on the foil side of the circuit board. Also be sure the two wires coming from the pushbutton switch are on the foil side of the circuit board.

3. Position the case top so the BNC jack is away from the foil side of the circuit board. Also be sure the wires coming from the microphone jack are away from the foil side of the circuit board, if you have it installed at this time. Then carefully slide the flanges on each end of the case top into the channels in the left and right side rails. Push the case top down onto the edge of the circuit board as far as possible. Then secure the case top to the circuit board with two 4-40 × 3/8" screws and two 4-40 nuts.

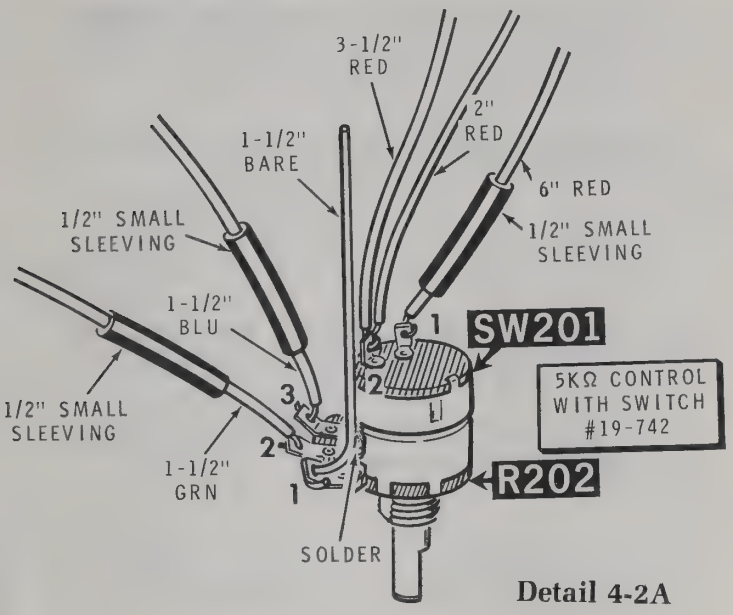
(✓) Connect the free end of the brown wire, coming from the pushbutton switch, to the indicated circuit board hole (S-1). NOTE: This hole is labeled GND on the component side of the circuit board.

(✓) Connect the free end of the yellow wire, coming from the pushbutton switch, to the indicated circuit board hole (S-1). NOTE: This hole is labeled T on the component side of the circuit board.

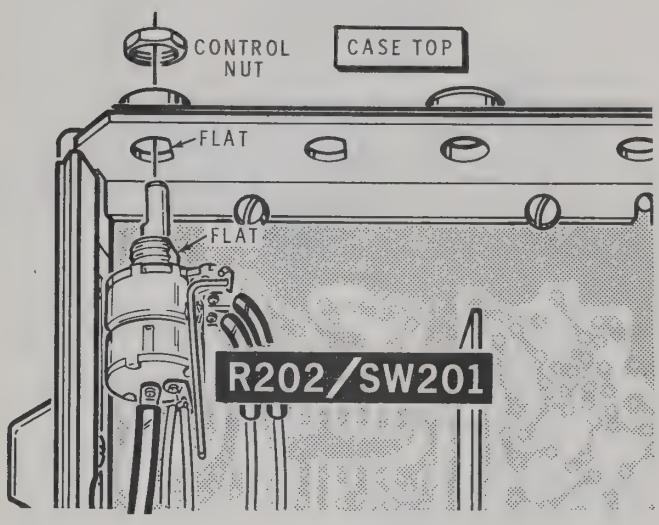
(✓) Push the wires coming from the pushbutton switch into the channel in the left side rail.



Detail 4-1G



Detail 4-2A



Detail 4-2B

Refer to Pictorial 4-2 (Illustration Booklet, Page 7) for the following steps.

() Prepare the following wires:

1-1/2" blue stranded
1-1/2" green stranded
6" red stranded
3-1/2" red stranded
2" red stranded

Refer to Detail 4-2A and connect one end of the prepared wires to a 5 kΩ control with switch (#19-742) as follows:

(✓) 1-1/2" blue wire to R202 lug 3 (S-1).

(✓) 1-1/2" green wire to R202 lug 2 (S-1).

(✓) Remove the insulation from a 1-1/2" white wire. Use this wire in the next step.

(✓) 1-1/2" bare wire to R202 lug 1 (S-1). Position the wire as shown. Then solder the wire to the side of the control. Do not cut off the remaining length of wire.

(✓) 6" red wire to SW201 lug 1 (S-1).

(✓) 3-1/2" red wire to SW201 lug 2 (NS).

(✓) 2" red wire to SW201 lug 2 (S-2).

(✓) Cut three 1/2" lengths of small sleeving. Then slide a piece of sleeving onto the blue, green, and longest red wires until it covers the control lugs as shown in the Pictorial.

(✓) R202/SW201: Refer to Detail 4-2B and mount the prepared control with switch in hole R202/SW201 in the case top. Match the flat on the control bushing with the flat in the hole. Then secure the control with a control nut.

(✓) Connect the free end of the wires coming from control R202/SW201 to the circuit board as follows. Be sure to route each wire as shown in the Pictorial.

() Bare wire to the indicated circuit board hole (S-1).

(✓) Green wire to hole Y (S-1).

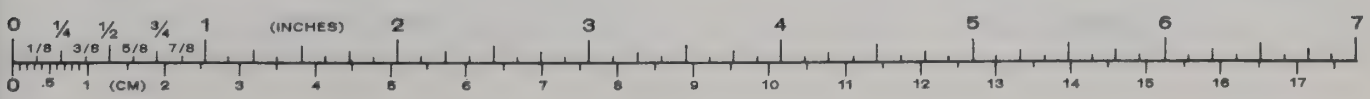
(✓) Blue wire to hole X (S-1).

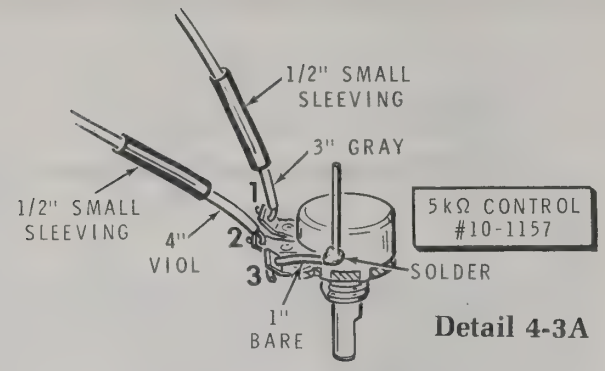
(✓) Short red wire from switch SW201 lug 2 to hole RED (S-1).

(✓) Long red wire from switch SW201 lug 2 to hole RED (S-1).

(✓) Red wire from switch SW201 lug 1 to hole +BATT (S-1).

(✓) Route the longer red wires you just connected into the channel in the left side rail.





Detail 4-3A

Refer to Pictorial 4-3 (Illustration Booklet, Page 7) for the following steps.

() Prepare the following wires:

4" violet stranded
3" gray stranded

Refer to Detail 4-3A and connect one end of the prepared wires to a 5 kΩ control (#10-1157) as follows:

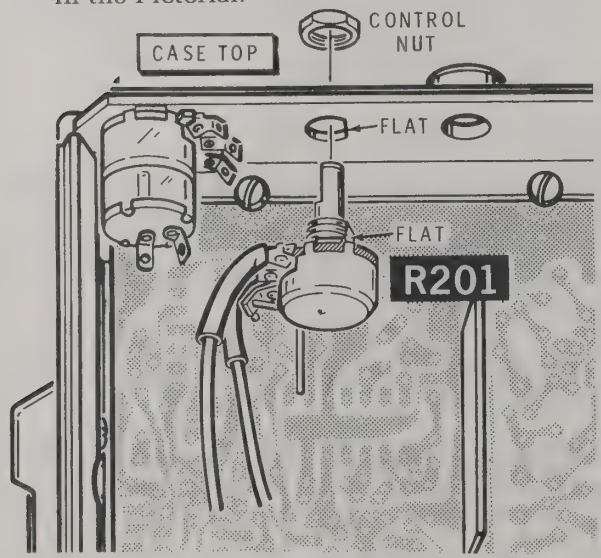
() Remove the insulation from a 1" white wire. Use this wire in the next step.

() 1" bare wire to lug 3 (S-1). Position the wire as shown. Then solder the wire to the side of the control. Do not cut off the remaining wire.

() 4" violet wire to lug 2 (S-1).

() 3" gray wire to lug 1 (S-1).

() Cut two 1/2" lengths of small sleeving. Then slide a piece of sleeving onto the violet and gray wires until it covers the control lugs as shown in the Pictorial.



Detail 4-3B

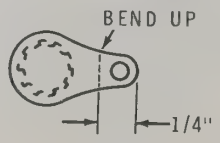
() R201: Refer to Detail 4-3B and mount the prepared control in hole R201 in the case top. Use a control nut to secure the control.

Connect the free end of the wires coming from control R201 to the circuit board as follows:

() Bare wire to the indicated circuit board hole (S-1).

() Violet wire to hole AA (S-1). Route this wire under control R202 as shown.

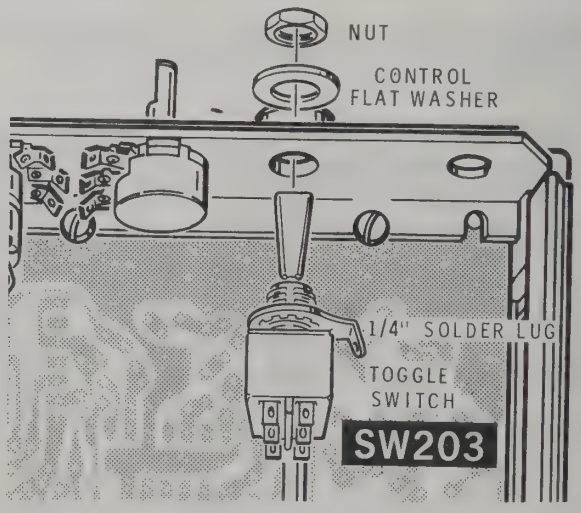
() Gray wire to hole Z (S-1). Route this wire under control R202 as shown.



Detail 4-3C

() Refer to Detail 4-3C and preform two 1/4" solder lugs by bending each lug at a 45° angle as shown. NOTE: Be careful when you bend these lugs; they are brittle. You will use one of these lugs in the following step. Set the remaining lug aside. It will be used later.

() SW203: Refer to Detail 4-3D and mount the toggle switch with a prepared 1/4" solder lug in the case top at SW203. Be sure to mount this switch so the lugs are positioned as shown in the Pictorial. Also position the solder lug as shown. Use the nut supplied with the switch and a control flat washer to secure the switch.



Detail 4-3D

() Prepare the following wires:

5-1/2″ yellow stranded	5-3/4″ brown stranded
1″ bare	6″ red stranded
5-3/4″ orange stranded	

NOTE: Keep the following wires down flat against the circuit board.

() Connect the 5-1/2″ yellow wire from switch SW203 lug 6 (S-1) to circuit board hole R (S-1).

() Connect the 1″ bare wire between switch SW203 lugs 3 (S-1) and 5 (S-1).

() Connect the 5-3/4″ orange wire from switch SW203 lug 4 (S-1) to circuit board hole P (S-1).

() Connect the 5-3/4″ brown wire from switch SW203 lug 2 (S-1) to circuit board hole L (S-1).

() Connect the 6″ red wire from switch SW203 lug 1 (S-1) to circuit board hole N (S-1).

Refer to Pictorial 4-4 (Illustration Booklet, Page 8) for the following steps.

() Refer to the inset drawing on the Pictorial and carefully bend each of the nine rotary switch lugs until they are straight and parallel with the switch body.

() Prepare the following white wires:

3/4″	2″
1″	2-1/2″

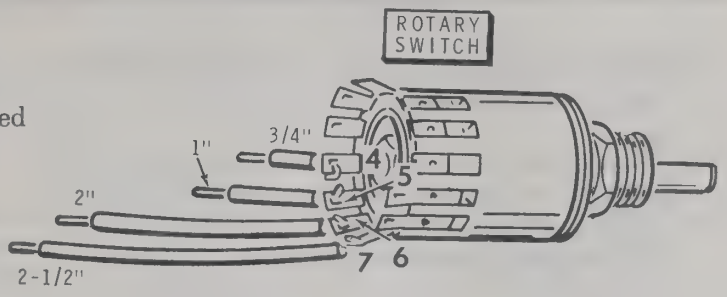
Refer to Detail 4-4A and connect one end of each prepared wire to the rotary switch as follows:

() 3/4″ to lug 4 (S-1).

() 1″ to lug 5 (S-1).

() 2″ to lug 6 (S-1).

() 2-1/2″ to lug 7 (S-1).

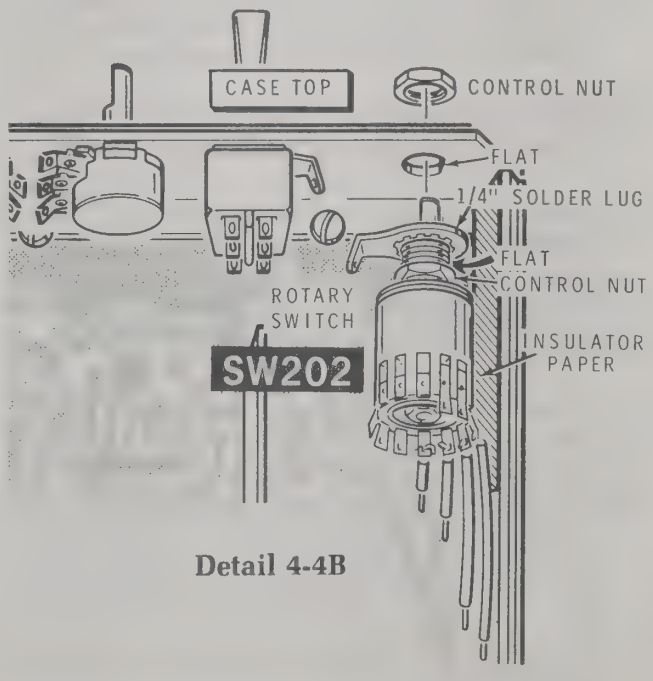


Detail 4-4A

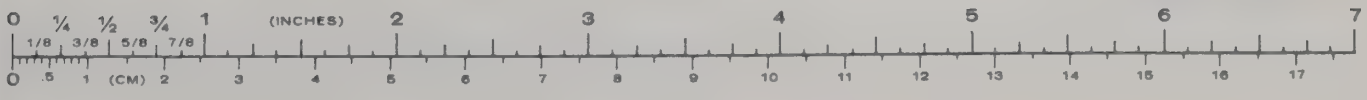
() Prepare a 1/4″ × 1-1/2″ piece of insulator paper.

() Carefully peel away the backing paper from the insulator paper. Then press the insulator paper onto the right side rail as shown in Detail 4-4B.

() SW202: Refer to Detail 4-4B and mount the rotary switch at SW202 in the case top. Use the preformed 1/4″ solder lug set aside earlier and two control nuts as shown. Be sure to turn the first nut all the way onto the switch before you install the switch in the case top. Also, position the solder lug so the small hole in this lug is lined up with the hole in the lug installed at switch SW203. Do not overtighten the control nut.



Detail 4-4B



() Remove the insulation from a 2" white wire. Use this wire in the next step.

() Connect and solder one end of the prepared wire to the indicated circuit board hole. Route the free end of this wire under switch SW203 as shown. Then connect the end of the wire to both control solder lugs. Solder the wire to both solder lugs.

() Prepare the following white wires:

3/4"	1"
3/4"	2"
2-1/4"	

NOTE: For clarity, the following wire lengths are not labeled on the Pictorial.

() Connect a 3/4" white wire from switch SW202 lug 2 (S-1) to circuit board hole 1 (S-1).

() Connect the free end of the wire coming from SW202 lug 4 to circuit board hole 3 (S-1).

() Connect a 3/4" white wire from switch SW202 lug 3 (S-1) to circuit board hole 2 (S-1).

() Connect a 2-1/4" white wire from switch SW202 lug 1 (S-1) to circuit board hole A (S-1).

() Connect the free end of the wire coming from switch SW202 lug 6 to circuit board hole 5 (S-1).

() Connect a 1" white wire from switch SW202 lug 9 (S-1) to circuit board hole 8 (S-1).

() Connect the free end of the wire coming from switch SW202 lug 5 to circuit board hole 4 (S-1).

() Connect the free end of the wire coming from switch SW202 lug 7 to circuit board hole 6 (S-1).

() Connect a 2" white wire from switch SW202 lug 8 (S-1) to circuit board hole 7 (S-1).

() Install a knob on the shaft of R202/SW201. Line up the flat in the knob with the flat on the shaft; then push the knob onto the shaft as far as it will go.

() Similarly, install knobs on controls R201 and switch SW202.

() Refer to Detail 4-4C (Illustration Booklet, Page 8) and prepare the 8" length of 8-wire cable (set aside earlier) as shown.

Connect the wires at end B of the prepared cable to the circuit board as follows. Be careful you do not burn the insulation on any nearby wires when you solder these wires to the foil.

() Blue wire to hole G (S-1).

() Violet wire to hole C (S-1).

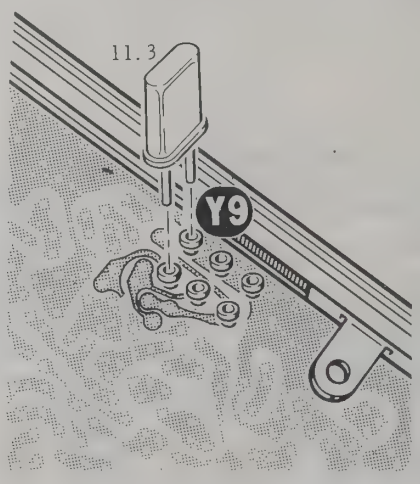
() Gray wire to hole E (S-1).

() Route the green wire as shown and insert the end of this wire through hole BL in the circuit board. The end of this wire will be connected later.

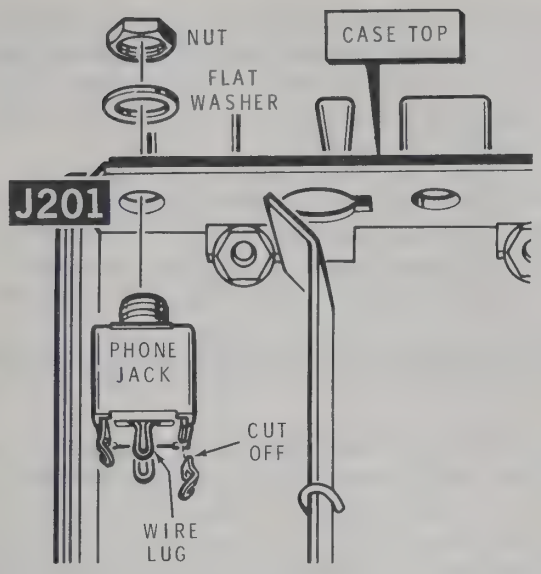
() Y9: Refer to Detail 4-4D and plug an 11.3 MHz crystal (#404-596) into the crystal socket pins at Y9.

() Y10: Plug a 10.7 MHz crystal (#404-603) into the crystal socket pins at Y10.

() Y11: Plug a 10.1 MHz crystal (#404-602) into the crystal socket pins at Y11.



Detail 4-4D



Detail 4-5A

Refer to Pictorial 4-5 (Illustration Booklet, Page 9) for the following steps.

() Position the phone jack so the wire lug is up as shown in Detail 4-5A. Then cut off the indicated lug.

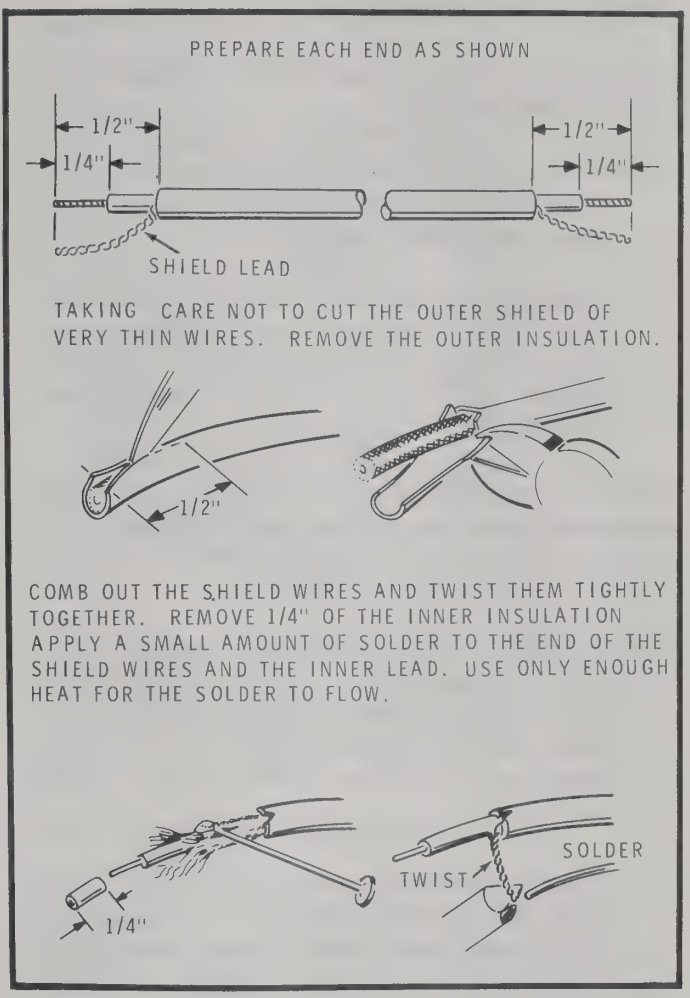
() J201: Refer again to Detail 4-5A and mount the phone jack at J201 in the case top. Use the flat washer and nut supplied with the jack. Be sure to install this jack so the three lugs are positioned as shown in the Pictorial.

() Connect the lead at the free end of resistor R203 to phone jack J201 lug 2 (S-1).

() Connect the free end of the green wire coming through circuit board hole BL to phone jack J201 lug 1 (S-1).

() Prepare a 4-1/2" blue stranded wire. Then connect this wire from circuit board hole S (S-1) to phone jack J201 lug 3 (S-1).

NOTE: If you have the microphone accessory jack installed in the Transceiver at this time, refer to "Wiring" in that Manual and connect the wires coming from the jack to the circuit board as you are directed.



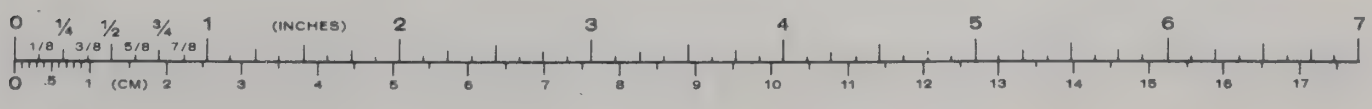
Detail 4-5B

() Refer to Detail 4-5B and prepare a 5" shielded cable as shown.

() At one end of the prepared cable, connect the inner lead to circuit board hole ANT (S-1) and the shield wires to hole GND (S-1). At the other end of this cable, connect the inner lead to jack J202 lug 1 (S-1) and the shield wires to the nearby control solder lug (S-1).

() Cut a 3/4" length of bare wire. Then install the wire in the circuit board at J. Solder the wire ends to the foil and cut off the excess wire lengths.

Set the Transceiver assembly aside temporarily.



CASE FRONT ASSEMBLY

Refer to Pictorial 4-6 (Illustration Booklet, Page 9) for the following steps.

() Place a soft cloth on your work surface so the case front will not be scratched when you perform the following steps.

() Position the case front as shown in the Pictorial. Then turn ten 4-40 twist-in nuts all the way into the ten bosses in the case front (DE, DF, DG, DH, DJ, DK, DL, DN, DP, and DR). Use the same procedure as you did earlier.

NOTE: Perform the next step **only** if the three microphone element lugs are not perpendicular to the two ears in the rubber mount as shown in the Pictorial.

() Carefully push the microphone element out of the rubber mount with your fingers. Position the three microphone lugs perpendicular to the two ears in the rubber mount. Then carefully push the microphone back into the rubber mount.

() A201: Install the microphone element in the case front at A201. Make sure lug 1, connected to the metal case, is positioned as shown. Push the two rubber ears over the studs in the case front. Then push the microphone element down so it is properly seated in hole A201.

() SP201: Mount the speaker to the case front as follows:

1. Place the speaker between bosses DG, DH, DJ, and DK in the case front so the lugs are positioned as shown.
2. Secure the speaker at DH, DJ, and DK with spring retainers and 4-40 × 1/8″ screws as shown.
3. Secure the speaker at DG with a spring retainer, a #6 solder lug, and a 4-40 × 1/8″ screw. Be sure to position the solder lug as shown in the Pictorial.

() Cut a foam gasket in half so you have two 3/4″ × 2-1/2″ gaskets. Carefully peel the backing paper from one side of one of these gaskets. Then press the gasket onto the case front in the area shown in the Pictorial.

() If you **do not** have the Auto Patch Accessory at the time, peel the backing paper from one side of the other gasket. Then press the gasket directly on top of the gasket you just installed.

Refer to Pictorial 4-7 (Illustration Booklet, Page 9) for the following steps.

NOTE: When you connect a wire to a speaker lug, as in the next step, disregard any numbers, color dots, or polarity markings that may be near the speaker lugs.

() Remove the insulation from a 2″ white wire. Then connect the wire from A201 lug 1 (S-1), through solder lug DG, to speaker SP201 lug 1 (S-1)

() C202: Cut each lead of a 330 pF ceramic capacitor to 1/2″. Then connect the capacitor from A201 lug 2 (NS) to solder lug DG (NS).

() C201: Cut each lead of a 330 pF ceramic capacitor to 1/2″. Then connect this capacitor from A201 lug 3 (NS) to solder lug DG (NS).

() Position the Transceiver assembly near the case front as shown in the Pictorial.

Connect the leads at the end of the 4-wire cable coming from the circuit board to the case front as follows:

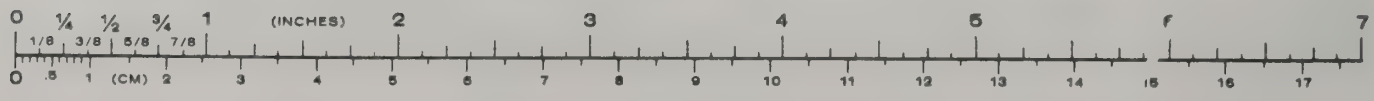
() Green wire to speaker SP201 lug 2 (S-1).

NOTE: When a wire passes through a lug, it counts as two wires in the solder instruction, one entering and one leaving the connection.

() Blue wire to solder lug DG (S-5).

() Violet wire to microphone element A201 lug 2 (S-2).

() Gray wire to microphone element A201 lug 3 (S-2).



() Carefully check the foil side of the circuit board for any of the following conditions:

1. Unsoldered connections.
2. Protruding leads which could touch together.
3. Solder bridges between adjacent foils.

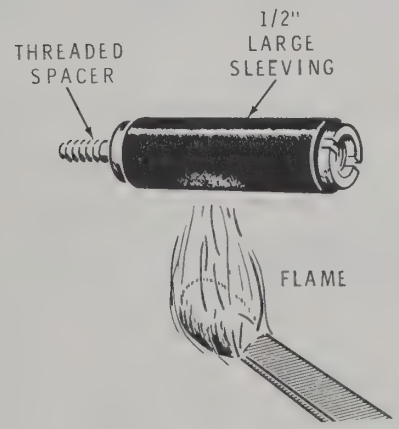
NOTE: If you have the Auto Patch Encoder Accessory, you may wish to assemble and install it at this time.

() Cut twelve 1/2" lengths of large (heat shrinkable) sleeving.

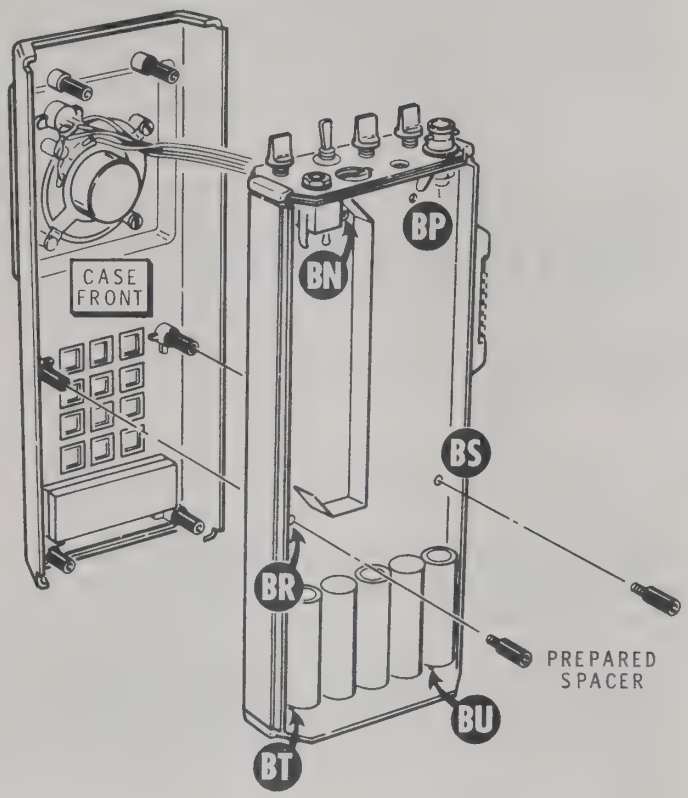
NOTE: You may wish to use the hex spacer to hold the 4-40 threaded spacers when you perform the next step.

() Refer to Detail 4-7A and use the heat of a flame from a match, lighter, or candle to shrink a length of sleeving on each of the twelve 4-40 threaded spacers. Be sure the sleeving is centered on the larger part of the spacer as shown before you apply the heat.

() Mount a prepared spacer at each of the six bosses in the case front at DE, DF, DL, DN, DP, and DR.



Detail 4-7A



PICTORIAL 4-8

NOTE: When you perform the next step, be sure the edges of the case top and case bottom seat properly inside the lips on the case front.

() Reposition any wires away from holes BN, BP, BR, BS, BT, and BU in the circuit board. Then refer to Pictorial 4-8 and use two threaded spacers to temporarily mount the case front to the Transceiver assembly at BR and BS as shown. NOTE: Be sure the 4-wire cable is folded up between the foil shield and the side rail. Also be sure the spacers pass through the side brackets on the foil side of the circuit board.

This completes the "Step-by-Step Assembly" of your Hand-Held 2-Meter Transceiver. Proceed to "Initial Tests."

INITIAL TESTS

The following resistance measurements are intended only to show whether short circuits or open circuits exist which could cause damage when you first apply the power. If you cannot obtain the correct ohmmeter indications in the following steps, refer to the "In Case of Difficulty" section. DO NOT proceed to the "Alignment" section until the difficulty has been corrected.

NOTES:

1. The resistance readings in the following steps were taken with a Heathkit Model IM-5218 VTVM. Readings taken with other ohmmeters (because of different measuring voltages and currents) may be considerably different.

2. The internal wiring of most ohmmeters is such that the positive terminal of the meter battery is connected to the positive test lead, or probe, and the negative battery terminal is connected to the negative (black) or common test lead. In some ohmmeters this wiring is interchanged and erroneous readings may result. Interchange the ohmmeter leads if the measurements do not check out correctly the first time.

Refer to Pictorial 5-1 (Illustration Booklet, Page 10) for the following steps. NOTE: The numbers at the beginning of each step correspond to the numbers on the Pictorial. This will help you find the test points quickly.

() Set your ohmmeter to the R × 1 range.

() Connect the common or negative ohmmeter lead to the solder lug on jack J202. Leave this lead connected to this solder lug for all of the resistance measurements.

() 1. Touch the VTVM test probe to J201 lug 3. The ohmmeter should indicate 5 Ω or greater.

() Set your ohmmeter to the R × 100 range.

() 2. Touch your VTVM probe to the foil on the top of the circuit board at hole AA. The ohmmeter indication should vary from less than 50 Ω to greater than 200 Ω as you vary the setting of the SQUELCH control.

() 3. Touch your VTVM probe to the bare portion of the inner shielded cable lead connected to hole ANT. The ohmmeter should indicate infinity (∞).

() 4. Touch your VTVM probe to the lead at the banded end of diode D11. The ohmmeter should indicate between 900 Ω and 1100 Ω.

() 5. Touch your VTVM probe to the foil on top of the circuit board at +BATT. The ohmmeter should indicate greater than 500 Ω with the ON-OFF switch ON, and infinity with the switch OFF.

() 6. Touch your VTVM probe to the bare wire at the top of the ferrite bead indicated in the Pictorial. The ohmmeter should indicate greater than 100 Ω.

() 7. Touch your VTVM probe to the lead at the top of resistor R62. The ohmmeter should indicate greater than 500 Ω.

() 8. Touch your VTVM probe to the indicated crystal socket pins at Y1 through Y8. The ohmmeter should indicate infinity.

() 9. Touch your VTVM probe to the lead at the top of choke L9. The ohmmeter should indicate greater than 50 Ω.

()10. Touch your VTVM probe to the foil on top of the circuit board at hole X. The ohmmeter should indicate greater than 4000 Ω.

()11. Touch your VTVM probe to the foil on top of the circuit board at hole Y. The ohmmeter indication should vary from 0 Ω to greater than 4000 Ω as you vary the setting of the VOLUME control.

This completes the "Initial Tests." If you obtained the proper ohmmeter indications in all of the checks, proceed to "Alignment."

ALIGNMENT

You can completely align your Transceiver using only a VTVM or VOM. This will result in satisfactory performance and will meet all pertinent FCC requirements. Following some of the alignment sections, you will find an alternate instrument alignment procedure. We recommend that you use this procedure whenever possible to achieve the best performance.

COIL CORES

During the alignment procedure, you will use the alignment tool to adjust a number of coil cores.

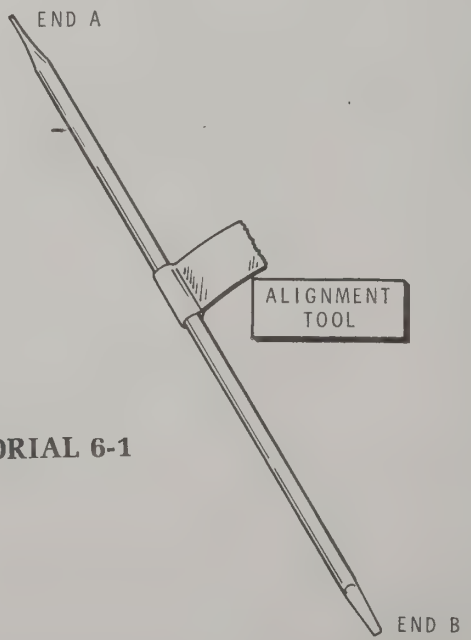
1. If a core will turn but offers resistance, put a very small amount of petroleum jelly on the inside of the coil form next to the core and then back the core out. Its threads will pick up the lubrication and the core will turn more easily.

2. If a coil core turns too easily and slips in the coil form, remove the core from the coil form. Then use long-nose pliers to carefully squeeze the sides of the coil form together a small amount and replace the core.

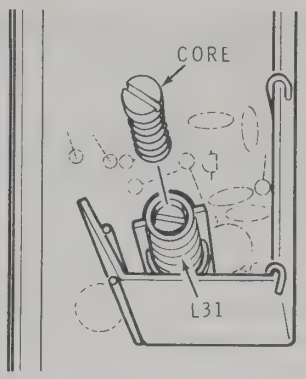
3. If you wedge the core down against the circuit board and cannot back it out, you will have to unsolder the coil pins from the circuit board enough to relieve the pressure. The desoldering braid supplied with this kit is very useful when you perform any unsoldering operation.

ALIGNMENT PREPARATION

() Refer to Pictorial 6-1 and place a small tape "flag" near the center of the alignment tool as shown. This will help you count the number of turns of the tool during alignment.



PICTORIAL 6-1



Detail 6-2A

Refer to Pictorial 6-2 (Illustration Booklet, Page 11) for the following steps.

(✓) Cut both leads of a 51 Ω, **1-watt** (green-brown-black) resistor to 1/2". Then temporarily tack solder the resistor from jack J202 lug 1 to the nearby solder lug.

(✓) Refer to Detail 6-2A and use the wider end of the alignment tool to remove and discard the core from coil L31. Then turn an aluminum core into this coil form until the slotted end of the core is flush with the top of the coil form.

(✓) Similarly remove and discard the core from coil L39. Then turn an aluminum core into this coil until the slotted end of the core is flush with the top of the coil form.

(✓) Y1: Plug a 146.94 MHz crystal (#404-598) into the crystal socket pins at Y1 on the circuit board.

NOTE: When you install crystals in the next step, do not install two adjacent (30 kHz) channels next to each other in the Transceiver. This could cause frequency adjustment problems later.

() Install any other crystals you have at this time in the other crystal socket pins as desired.

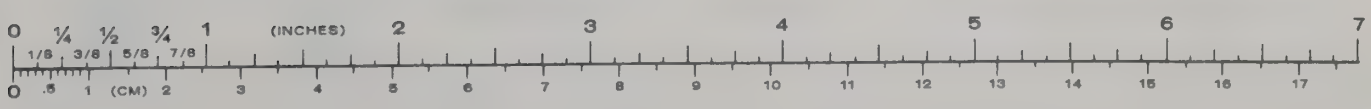
() Use the alignment tool to rotate the core in each of the following coils as necessary until the top of the core is flush with the top of the coil form. Then rotate the core in each coil clockwise as shown. Use the flag on the alignment tool to count the rotations of the tool.

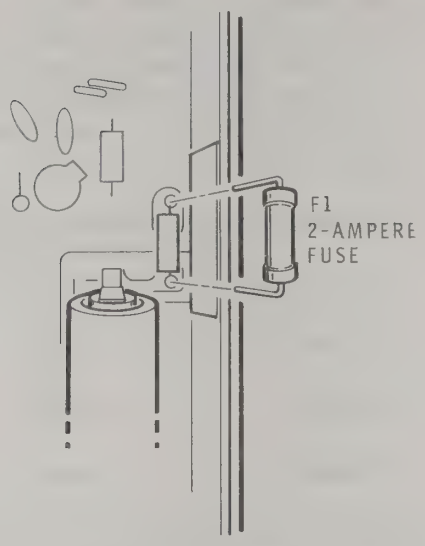
L13 through L20	4 turns
L22 and L23 (violet)	2 turns
L24 (yellow)	1 turn
L26 (red)	2 turns
L31 (red)	3 turns
L32, L34, L35 and L36 (red)	leave at top of form
L37 (yellow)	leave at top of form
L39 (red)	leave at top of form
L1 and L2 (yellow)	leave at top of form
L3 (orange)	leave at top of form

() Preset the DEVIATION control (R88) and the POWER ADJUST control (R114) fully counterclockwise.

() Preset the controls and switches on the case top as follows:

VOLUME	OFF
SQUELCH	Fully counterclockwise.
OFFSET	0
CHANNEL	To the channel nearest the center of your frequency range (or to position 1 if only one crystal is installed at this time).





Detail 6-2B

() Cut a 1" × 1/4" piece of insulator paper.

() Carefully peel the backing paper from the insulator paper. Then press the insulator paper onto the left side rail adjacent to the location for fuse F1.

() Be sure the Transceiver is off (VOLUME control fully counterclockwise until it clicks).

() F1: Cut both leads of a 2-ampere fuse to 1/4". Then form the leads as shown in Detail 6-2B and plug the fuse into the crystal socket pins in the circuit board at F1.

() Refer to the inset drawing on the Pictorial and screw the antenna into the BNC shell. Set the antenna assembly aside temporarily.

NOTE: If you do not obtain the proper results in any of the following steps, refer to the "In Case of Difficulty" section and correct the problem before you proceed.

() Connect the line cord on the battery charger to the appropriate AC outlet. Then refer to Pictorial 6-3 (Illustration Booklet, Page 11) and insert the Transceiver into the charger case as shown. The red pilot light on the charger should light.

NOTE: Read the information under "Battery Charging" on Page 81 before you perform the next step.

() Charge the batteries for at least 12 hours before you continue to the following alignment sections.

OSCILLATOR CHAIN ALIGNMENT

Refer to Pictorial 6-4 (Illustration Booklet, Page 12) for the following steps.

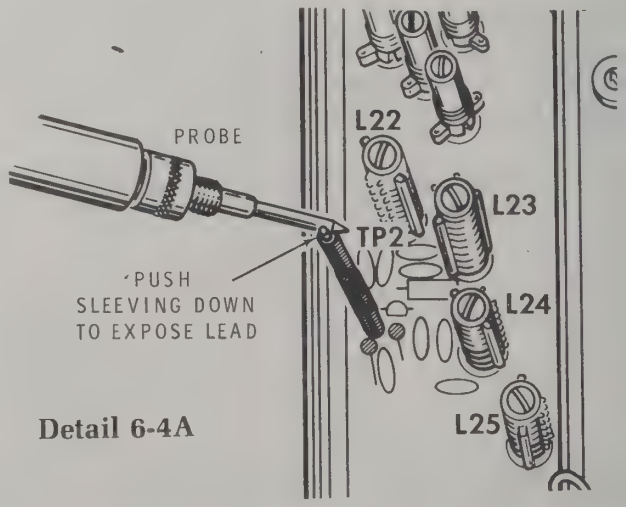
() Use a DC voltmeter to measure the voltage of each battery. If any battery measures zero or the incorrect polarity, check the battery installation. If the battery is correctly installed, it may be defective. Use the Parts Order Form (supplied) to order a new one. (Since this part is still under Warranty, be sure to fill in the "Model #," "Purchase Date," etc., information.)

NOTE: Voltages on the various test points are approximate (±30%) and are intended only to give you an indication that the particular circuit is operating.

() Set the VTVM or VOM to measure +5 volts DC.

() Connect the common lead of the meter to the solder lug at J202.

() Refer to Detail 6-4A and connect the probe of your meter to TP2.



Detail 6-4A

NOTE: The voltages indicated in the following steps were taken with a VTVM. These voltages may be lower if you use a VOM.

() Turn the VOLUME control clockwise until it clicks. The voltage at TP2 should indicate 1 volt or higher and you should hear noise coming from the speaker.

() Adjust coils L22 and L23 (violet) for a maximum meter indication (2.1 V). Repeat this step until you notice no further improvement on the meter.

() Connect the meter probe to TP3. Then adjust coil L24 (yellow) for a maximum indication on the meter.

() With the meter still connected to TP3, adjust coil L26 (red) for a minimum indication on the meter (1.1 V).

() Turn the Transceiver off.

IF ALIGNMENT

NOTE: The next six steps assume that you are performing these adjustments for the first time. If you are performing these adjustments at a later date, you will have to unsolder the lead (coming from the top of coil L30) from the circuit board before you proceed.

() Refer to Detail 6-4B and temporarily tack solder the 12 kΩ (brown-red-orange) resistor from the free lead of choke L30 to the top lead of resistor R62. Be sure the leads of the resistor and the choke do not touch anything else.

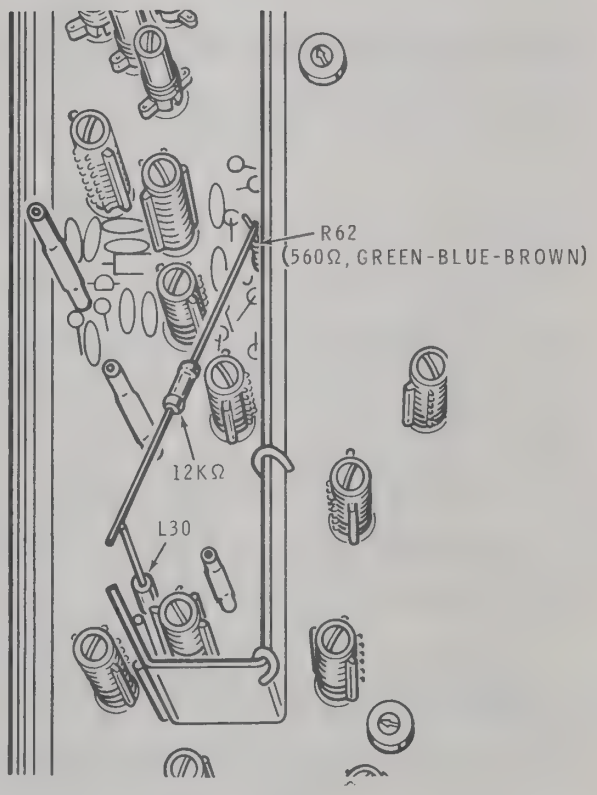
() Connect the meter probe to TP1. Then turn the Transceiver on and adjust coils L4, L6, and L7 for a maximum meter indication. Continue adjustment until no further improvement is noted. (The improvements may be slight but are critical to the IF passband.) This normally requires three to four repeats of the adjustments.

() Turn the Transceiver off and unsolder the 12 kΩ resistor you connected between choke L30 and resistor R62. Do not cut the lead of choke L30.

() Remove the spacers from BR and BS on the circuit board. Then carefully remove the case front.

() Insert the free lead of choke L30 into its corresponding circuit board hole. Then solder the connection and cut off any excess lead lengths.

() Mount the case front to the Transceiver assembly. Use six prepared spacers to secure the case front at BN, BP, BR, BS, BT, and BU.



Detail 6-4B

RECEIVER FRONT END ALIGNMENT

NOTE: Be sure the 51 Ω resistor is still connected across antenna jack J202 before you proceed with either of the following alignment procedures.

() Connect your meter probe to TP1, if this has not already been done.

() Set the meter to read 1.5 VDC.

ALIGNMENT WITHOUT INSTRUMENTS

() Turn the Transceiver on and adjust coils L3 (orange), L2 (yellow), and L1 (yellow) for a maximum meter indication (.5 to 1.5 VDC). Repeat this step until you notice no further improvement on the meter.

() Turn the Transceiver off.

ALIGNMENT WITH INSTRUMENTS

() Set the meter to read 5 VDC.

() Connect a suitable signal generator (capable of generating an RF signal at the crystal frequency) to jack J202.

() Turn the Transceiver on and adjust the signal generator frequency for the best quieting. Then adjust the output of the generator for a 2 VDC indication on your meter. Keep adjusting the output of the generator, while you perform the next step, so the meter indication remains near 2 VDC.

NOTE: Be sure to adjust the coils in the next step in the order listed.

() Adjust coils L3 (orange), L2 (yellow), and L1 (yellow) for a maximum meter indication. Repeat this step until you notice no further improvement on the meter.

() Turn the Transceiver off and disconnect the signal generator from jack J202.

TRANSMITTER ALIGNMENT

INITIAL ALIGNMENT

NOTE: The following alignment procedure is for the 146 to 148 MHz segment. For a different 2 MHz segment, select the crystal in the next step which is nearest the center of your 2 MHz segment.

() Set the CHANNEL switch to 1 (146.94 MHz).

() Be sure the OFFSET switch is at 0 (simplex).

() Connect your meter probe to TP4.

() Turn the Transceiver on and momentarily push the PTT bar on the left side rail. The meter should indicate at least 1 volt.

() Again push the PTT bar and adjust coil L26 (red) for a maximum indication on the meter.

() Connect your meter probe to TP5. Then push the PTT bar and adjust coil L32 (red) **clockwise** for the first voltage peak. Then adjust coil L31 (red) ± one turn for a maximum meter indication.

() Push the PTT bar and again adjust coils L32 (red) and L31 (red) for a maximum meter indication.

() Push the PTT bar and adjust coil L34 (red) clockwise for a dip in the meter indication.

() Connect your meter probe to TP6. Then push the PTT bar and adjust coil L35 (red) and then L34 (red) for a maximum meter indication (0.8 volt). Repeat this step until you notice no further improvement.

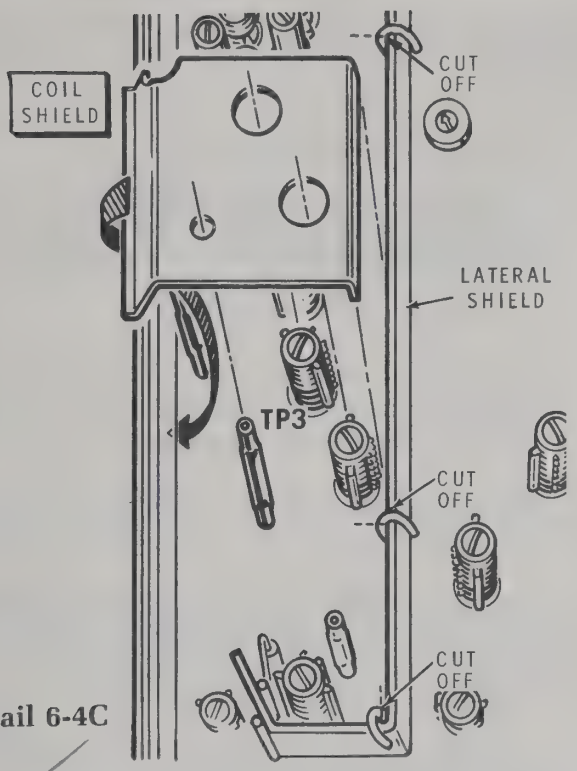
() Push the PTT bar and adjust coils L31 (red), L32 (red), L34 (red), and L35 (red) until you notice no further improvement.

() Connect your meter probe to TP7 and turn POWER ADJUST control R114 fully clockwise.

() Push the PTT bar and adjust coil L36 (red) for a maximum meter indication (.6 volt).

() Connect your meter probe to TP8. Then push the PTT bar and adjust coil L37 (yellow) and L39 (red) for a maximum meter indication.

() Turn the Transceiver off.



Detail 6-4C

() Refer to Detail 6-4C and cut off the three indicated bare wires even with the top of the lateral shield.

() Refer again to Detail 6-4C and install the coil shield onto the circuit board as shown. Be sure test point TP3 enters the small hole in the shield as shown. Also be sure TP2 is in the notch in the corner of the shield, as shown in the Pictorial. Then tack solder the corners of the shield to the lateral shield.

() Turn the Transceiver on.

() Be sure the SQUELCH control is fully counterclockwise.

NOTE: It is not necessary to push the PTT bar in the next step.

() Connect your meter probe to TP3 and adjust coils L22 (violet), L23 (violet), and L24 (yellow) for maximum indication on the meter.

() Bend the free ends of TP2 and TP3 over so they are flat against the coil shield. NOTE: Do not be concerned if the bare portion of the test points touch the shield.

NOTE: Do not adjust the coils in the next four steps more than one turn either way. To do so may cause you to align the transmitter on the local oscillator signal.

() Connect your meter probe to TP4. Then push the PTT bar and adjust coil L26 (red) for a maximum meter indication.

() Connect your meter probe to TP6. Then push the PTT bar and adjust coils L31 (red), L32 (red), L34 (red), and L35 (red) for a maximum meter indication.

() Connect your meter probe to TP7. Then push the PTT bar and adjust coil L36 (red) for a maximum meter indication.

() Connect your meter probe to TP8. Then push the PTT bar and adjust coil L37 (yellow) for a maximum meter indication.

FINAL ALIGNMENT

() Use a DC voltmeter to again measure the voltage of each battery. If any battery measures greatly less than 1 volt, it may be defective. Use the Parts Order Form (supplied) to order a new one.

() Set the CHANNEL switch to position 1 (or the crystal closest to the center of your 2-MHz segment).

() Set the OFFSET switch to +.6.

() Be sure your meter is set to read 1.5 VDC.

() Be sure the 51 Ω resistor is still connected across jack J202.

() Connect your meter probe to TP6. Then push the PTT bar and adjust coil L32 (red) for a maximum meter indication.

() Push the PTT bar and alternately change the OFFSET switch between +.6 and −.6. Note which switch position produces the lowest indication.

() Set the OFFSET switch in the position which produced the lowest indication.

() Push the PTT bar and adjust coil L31 (red) for a maximum meter indication.

() Push the PTT bar and alternately change the OFFSET switch between +.6 and −.6. Adjust coil L32 (red) until the meter indications are the same (must be less then .02 volt difference).

Power Adjustment Without a Wattmeter.

NOTE: The next two adjustments will show very little, if any, improvement. At maximum power output, you can leave coil L39 (red) at the top of the coil form.

() Connect your meter probe to TP8, if this has not already been done. Then push the PTT bar and adjust control R114 for an indication of 2.0 to 2.2 volts on the meter (this is approximately 2 watts output).

() Push the PTT bar and adjust coil L37 (yellow) for a maximum meter indication. Then adjust coil L39 (red) for a maximum indication on the meter or to the point where the meter indication just begins to drop.

Power Adjustment With a Wattmeter

() Unsolder the 51 Ω resistor from across jack J202.

() Connect an RF wattmeter and a 50 Ω dummy load to jack J202. NOTE: The wattmeter must be capable of indicating at least 3 watts correctly at 146 MHz.

NOTE: The next two adjustments will show very little, if any, improvement. At maximum power output, you can leave coil L39 (red) at the top of the coil form.

() 1. Push the PTT bar and set control R114 for the desired output.

() 2. Push the PTT bar and adjust coils L37 (yellow) and L39 (red) for a maximum indication on the wattmeter.

() 3. Repeat steps 1 and 2 until you obtain the output power you desire.

Deviation Adjustment

() If you do not have a deviation monitor available, preset the DEVIATION control (R88) to the center of its rotation. This setting should be very close to the proper deviation. Readjust the control as necessary after you place the Transceiver into operation.

() If you have a deviation monitor available, set the DEVIATION control (R88) for the desired deviation (usually 4.5 to 5 kHz).

Frequency Adjustment Without a Frequency Counter

() Be sure the Transceiver is off.

() Temporarily tack solder 1″ bare wires to IC1 pins 7 and 10.

() Set your VTVM to read 1.5 VDC.

() Connect the common lead of the meter to the bare wire connected to IC1 pin 10 and the meter probe to the bare wire connected to pin 7.

() Be sure the 51 Ω resistor is still connected across jack J202.

() Turn the Transceiver on and write down the meter indication. NOTE: This indication will be fluctuating. Estimate the indication as close as possible.

() Unsolder the 51 Ω resistor from jack J202. Then connect the antenna to jack J202.

NOTE: You must be receiving a signal on each of your channels when you perform the next step.

() Adjust the frequency coil (L13 through L20) for each channel for the same meter indication you obtained above.

() Disconnect the meter from the bare wires on IC1. Then unsolder the bare wires.

Frequency Adjustment With a Frequency Counter

NOTE: The frequency counter must be capable of indicating correctly at 146 MHz.

() Loosely couple the RF signal from the Transceiver to the counter. Be careful you do not overdrive the frequency counter.

() Push the PTT bar and adjust the frequency coil (L13 through L20) for each channel until the counter indicates the correct frequency.

() Turn the Transceiver off.

This completes the "Alignment." Proceed to "Final Assembly."

FINAL ASSEMBLY

Refer to Pictorial 7-1 (Illustration Booklet, Page 13) for the following steps.

() Read, sign, and date the FCC portion of the FCC/Alignment label. Then carefully peel away the backing paper and press the label onto the inside of the case back as shown in Detail 7-1A.

() Cut the remaining foam gasket in half so you have two 3/4" × 2-1/2" gaskets. Then carefully peel away the backing paper from one side of either gasket and press the gasket on the inside of the case back below the FCC/Alignment label.

NOTE: When you perform the next step, be sure the edges of the case top and case bottom seat properly inside the lips on the case back. You may have to push inward on the ends on the top and bottom pieces.

() Position the case back so the recess is toward the top of the Transceiver. Then use six 4-40 x 5/16" black flat head screws to mount the case back to the Transceiver as shown in the Pictorial.

Refer to Pictorial 7-2 (Illustration Booklet, Page 13) for the following steps.

NOTES:

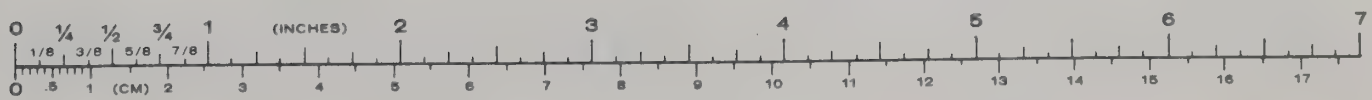
1. Be sure to position each label, in the next two steps, as shown in the Pictorial before you press the label in place.

2. Do not perform the next step if you have the Auto Patch Encoder Accessory. A different front label is included with that kit.

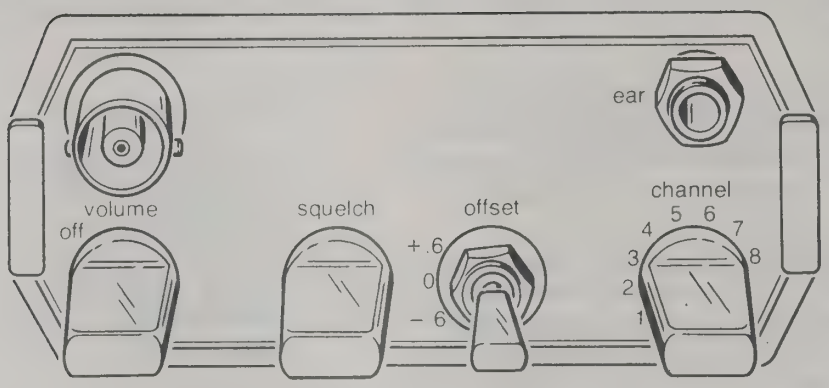
() Carefully peel away the backing paper from the front label. Then press the label into the recessed area in the case front.

() Carefully peel away the backing paper from the channel label. Then press the label into the recessed area in the case back.

This completes the assembly of your Transceiver. Proceed to the "Operation" section.



OPERATION



PICTORIAL 8-1

Refer to Pictorial 8-1 for the locations and functions of switches, controls, and jacks described in this section of the Manual.

VOLUME Control

Use the VOLUME control to adjust the sound output from the speaker or earphone to the desired listening level. This control also turns the power off in the fully counterclockwise position.

SQUELCH Control

To adjust the SQUELCH control, first turn it fully counterclockwise. Turn the Transceiver on and set the VOLUME control so you hear background noise at average volume. Then turn the SQUELCH control knob clockwise until the noise just disappears. Setting the SQUELCH control further clockwise requires a stronger received signal to break the squelch.

OFFSET Switch

The OFFSET switch has three positions. The crystals supplied with this kit allow you to operate this Transceiver on one receive frequency and one of three transmit frequencies. With the switch set in the middle (0) position, the receive and transmit frequency are the same (146.94 MHz, for example). With the switch set at +.6, the transmit frequency is 600 kHz higher than the receive frequency (146.94 MHz on receive and 147.54 MHz on transmit). With the switch set at −.6, the transmit frequency is 600 kHz lower than the receive frequency (146.94 MHz on receive and 146.34 MHz on transmit). NOTE: The offset crystals may be changed to provide alternate transmitter offset frequencies. Refer to "Offset Oscillator Crystals" on Page 79 for information concerning these crystals.

CHANNEL Switch

Use this switch to select any one of eight crystals. A crystal must be plugged into one of the sockets for channels 1 through 8 before you can use any of these channels. You will need a crystal for each frequency you intend to use. (This Transceiver uses the same crystal for both receive and transmit.) NOTE: You may order a crystal certificate, Model VFA-2031-4, from the Heath Company for each crystal you desire.

ANTENNA Jack

You can use an external antenna, fed with 50 ohm cable, with this Transceiver. When you use an external antenna, disconnect the flexible antenna from the jack on top of the Transceiver. Then use the same jack to connect the external antenna.

EARPHONE Jack

The EARPHONE jack allows you to connect an earphone (supplied) for private listening. When you plug the earphone into this jack, the internal speaker is automatically disconnected.

BATTERY CHARGING

The battery charger furnished with this kit supplies about 40 mA of current to the battery pack when it is being charged. The charger limits the current to a safe value so the batteries can never be overcharged.

Under normal operation, the batteries will last 7 to 10 hours on a full charge. Charge the batteries from 14 to 24 hours.

You can operate the Transceiver in the receive mode while the batteries are being charged. To do so, however, will cause the batteries to take twice as long to charge. If you transmit while the batteries are being charged, you may receive reports of a 60 Hz hum on your modulation.

ADDITIONAL INFORMATION

The batteries in your Transceiver are rated at 500 mAh. This means that if the ten cell packs in your Transceiver are drained at 500 mA for one hour, the voltage would still be at or above ten volts. Ten volts (or 1 volt per cell) is considered the end point and marks the point at which the "internal impedance" of the battery begins to greatly increase. Below ten volts, and if the receiver squelch is adjusted for threshold, the high impedance of the battery will cause the receiver to "motorboat."

Ni-Cad (nickel-cadminum) batteries are not immortal. However, with reasonable care, they should provide a good service life for your Transceiver. The life of a Ni-Cad battery may be reduced by one of the following three conditions:

Sustained overcharging heat

Cell reversal

Memory

Sustained overcharging heat has been eliminated as long as you use the battery charger supplied with the kit. The current in this charger is limited to less than 50 milliamperes.

Cell reversal happens when one of the cells in the battery is discharged down to zero. The remaining cells force a current through the discharged cell, causing the voltage across the cell to reverse and begin to destroy the cell chemistry. To avoid this condition, you should take care not to discharge the battery pack below ten volts. If you feel a battery has gone bad, a simple voltmeter test, measuring the voltage across each cell, will usually turn up the bad one. It is usually best to run the Transceiver for an hour or two after

a charge cycle and then examine the cells and replace the bad ones. Typical voltages are:

1.38 volts max at charge time.

1.25 volts typical voltage during discharge.

1.00 volts end point.

Memory causes an apparent shortening of the battery capacity by reducing the typical voltage, during the discharge cycle, down to one volt in a few minutes of operation. It occurs when a Ni-Cad cell is consistently exercised only ten percent of its capacity and then recharged.

Memory may be reversed by a series of full charge/discharge cycles. The battery pack will normally improve after each cycle. It may not be a bad idea as you complete your initial testing to run the battery pack down and then recharge to get off on a good start.

Since the charging efficiency for a Ni-Cad is about 66% and your charger will typically provide 40 mA, it will take about 19 hours to totally recharge a completely discharged battery pack.

While a Ni-Cad battery system is not ideal, it is the best system currently available for battery-powered communication equipment like your Transceiver. These batteries can and will take a lot of abuse; and if you avoid over-discharging and over-charging, they will give you many dependable recycles.

ORDERING CRYSTALS

Crystals, in addition to those furnished, should be ordered through normal crystal suppliers. You may order a crystal certificate (for local oscillator crystals only). Model VFA-2031-4, from the Heath Company for each crystal. NOTE: Crystals obtained using a crystal certificate from Heath Company are correlated to the radio using a zero phase π network measurement technique. Note that the following specifications differ for local oscillator and offset oscillator crystals.

LOCAL OSCILLATOR CRYSTALS

Crystal frequency (Operates on the fundamental frequency at parallel resonance.)	=	$\frac{\text{Operating frequency (MHz)} - 10.7\ \text{MHz}}{9}$
Tolerance at 25°C	=	.002% or better.
Load capacity	=	47 pF.
Equivalent series resistance (Rs)	=	25 Ω max. (25°C).
Motional capacitance (Cm)	=	.023 pF ± 10%.
Static capacitance (Co)	=	5 pF ± 1 pF @ 1 MHz (pin to pin, case unguarded.)
Drive level	=	.5 mW or less.
Stability	=	± 40 parts per million (−30°C to +60°C).
Holder*	=	HC-25U.
*Holder pin size	=	.040″ dia.
Holder pin spacing	=	.192″.

OFFSET OSCILLATOR CRYSTALS

Crystal frequency (Operates on the fundamental frequency at parallel resonance.)	=	10.7 MHz − offset frequency in kHz (transmitter frequency below the receiver frequency).
		OR
	=	10.7 MHz + offset frequency in kHz (transmitter frequency above the receiver frequency).
Tolerance at 25°C	=	.003% or better.
Load capacity	=	47 pF.
Equivalent series resistance (Rs)	=	25 Ω max. (25°C).
Motional capacitance (Cm)	=	.023 pF ± 20%.
Static capacitance (Co)	=	5 pF ± 1 pF @ 1 MHz (pin to pin, case unguarded.)
Drive level	=	.5 mW or less.
Stability	=	±40 parts per million (−30°C to +60°C).
Holder*	=	HC-25U.
*Holder pin size	=	.040″ dia.
Holder pin spacing	=	.192″.

AVAILABLE ACCESSORIES

If you need additional transmitter power, you may feed the signal from your Transceiver to the Heathkit Model HA-201A, low power (10 watts), 2-Meter FM Amplifier.

A holster-type carrying case, Model VFA-2031-2, allows you to carry your Transceiver on your belt.

An Auto Patch Encoder Accessory, Model VFA-2031-3 is designed to be used with your Transceiver. This Encoder Accessory mounts inside your Transceiver behind the case front and connections are easily made to the circuit board. The Auto Patch Encoder Acessory is compatible with the telephone tone system.

An Audible/Subaudible Tone/Burst Accessory, Model VFA-2031-5, provides you with a 2-tone, switch selectable, subaudible tone (67 to 210 Hz) or tone burst (1500 to 2500 Hz) capability. The 3-position switch for this accessory mounts in a hole in the top of the Transceiver.

An external Push-to-Talk Microphone Accessory, Model VFA-2031-6, allows you to operate the transceiver without removing it from the holster case.

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps listed below in the "Visual Tests." After you complete the "Visual Tests" refer to the Troubleshooting Charts.

NOTE: Refer to the "Circuit Board X-Ray Views" (Illustration Booklet, Pages 15 and 16) for the physical location of parts on the circuit board.

VISUAL TESTS

1. Recheck the wiring. Trace each lead with a colored pencil on the Pictorial as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something that you have consistently overlooked.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all connections to make sure they are soldered as described on Page 11. Be sure there are no solder "bridges" between circuit board foils.

3. Check to be sure all transistors and diodes are in their proper locations. Make sure each lead is connected to the proper point. Make sure that each diode band is positioned above the band printed on the circuit board or as directed in its step.

4. Check electrolytic capacitors to be sure their positive (+) mark is at the correct position.

5. Check to be sure that each IC is properly installed in its socket, and that the pins are not bent out or under the IC. Also be sure the IC's are installed in their correct positions.

6. Check the values of the parts. Be sure in each step that you wired the correct part into the circuit, as shown in the Pictorial. It would be easy, for example, to install a 22 kΩ (red-red-orange) resistor where a 2200 Ω (red-red-red) resistor should have been installed.

7. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

8. Look between each circuit board and the chassis to be sure all leads were cut off short.

9. A review of the "Circuit Description" may also help you determine where the trouble is.

10. Inspect each miniature ceramic capacitor closely for cracks or very fine breaks. Use the magnifying glass if necessary.

If you have still not located the trouble after the "Visual Tests" are completed, and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram (fold-in). Read the "Precautions for Troubleshooting" before you make any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as ±20%.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when you test diode and transistor circuits. Although they have almost unlimited life when used properly, they are much more sensitive to excessive voltage or current than tubes.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short across components or voltage sources, it is very likely to cause damage to one or more transistors or diodes.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of this Manual. Your Warranty is located inside the front cover.

TROUBLESHOOTING CHARTS

The following charts list the "Condition" and the "Possible Cause" of a large number of malfunctions. Under some of the conditions you will find several tests you can make. These should help you narrow down the problem to a specific area within a particular circuit. If a particular part or parts are mentioned (transistor Q8, for example, or switch SW203) as a possible cause, check these parts to see if they are wired or installed incorrectly. Also check to see if an improper part was installed at that location. It is also possible, on rare occasions, for a part to be faulty.

RECEIVER PROBLEMS

CONDITION	POSSIBLE CAUSE
No sound from the speaker.	1. Fuse F1. 2. Earphone jack J201. 3. Speaker SP201.
1. Battery voltage should be 12.5 volts.	1. Any battery cell.
2. Turn Transceiver on and check for battery voltage on both lugs of switch SW201.	1. Switch SW201. 2. Wiring error.
3. Voltage on collector (c) of transistor Q7 should be greater than 8 volts.	1. Transistor Q7. 2. Diodes D12. 3. Resistor R44.
4. Voltage on IC3A pin 1 should be less than 3 volts.	1. IC3. 2. Diode D5.
5. Voltage on collector (c) of transistor Q8 should be less than 1 volt.	1. Transistor Q8. 2. Switch SW204.
6. Voltage on collector (c) of transistor Q6 less than 5 volts.	1. Transistor Q6.
7. Voltage on IC2 pin 12 should be greater than 5 volts.	1. Capacitor C46. 2. IC2 installed wrong.
8. Voltage on IC1 pin 11 should be greater than 8 volts.	1. Coil L9. 2. Capacitors C33 or C34.
9. Voltage on IC1 pin 9 should be greater than 5 volts.	1. Capacitor C36.
Receiver "motorboats" at squelch threshold.	1. Low battery charge. 2. Transistor Q6.
Low receiver sensitivity.	1. Coils L1, L2, L3, L4, L6, or L7 misadjusted. 2. Crystal not on frequency. 3. Low local oscillator injection — refer to "Miscellaneous Problems."
High receiver distortion.	1. Filter FL3 or associated components. 2. Coils L4 or L6 misadjusted. 3. Crystal not on frequency. 4. Low battery voltage. 5. IC2.
Receiver does not turn off during transmit function. (Possible squealing.)	1. Diodes D7 or D8.

TRANSMITTER PROBLEMS

CONDITION	POSSIBLE CAUSE
No voltage on transmitter test points.	
1. Voltage on emitter (E) of transistor Q8 should be 12.5 volts.	1. Wiring error.
2. Push PTT bar and check voltage across this switch (SW204). The voltage should be less than .5 volt.	1. Switch SW204. 2. Wiring error.
3. Voltage on base (B) of transistor Q8 should be less than 10 volts.	1. Transistor Q8.
Transmitter inoperative.	1. Wiring error.
1. Voltage on TP4 should be greater than 1 volt.	1. Coil L31. 2. No local oscillator injection — refer to "Miscellaneous Problems." 3. Crystals Y9, Y10, or Y11. 4. Diodes D15, D16, or D17. 5. Transistor Q12. 6. Switch SW203 wiring.
2. Voltage on TP5 should be greater than .9 volt but less than 3 volts.	1. Coils L31 or L32 misadjusted. 2. Aluminum slug not in coil L31. 3. Capacitor C97. 4. Transistor Q14. 5. Capacitor C102. 6. Resistor R107.
3. Voltage on TP6 should be greater than .9 volt but less than 3 volts.	1. Coils L34 or L35 misadjusted. 2. Transistor Q15. 3. Capacitors C105, C107, or C108. 4. Resistor R113.
4. Voltage on TP7 should be greater than .9 volt but less than 3 volts.	1. Coil L36 misadjusted. 2. Resistors R114 or R118. 3. Capacitors C112, C113, or C114. 4. Transistor Q16.
5. Voltage on TP8 should be greater than 2 volts.	1. Transistor Q17. 2. Coil L38 wound wrong. 3. Capacitors C112, C116, C117, C122, C123, C124, C125, or C128. 4. Diodes D11 or D18. 5. Coils L39 or L40. 6. Resistor R125.
Low power output (TP8 greater than 3 volts).	1. Diode D11. 2. Resistor R125. 3. Coil L41 wound wrong. 4. Capacitors C123, C124, C125, or C126.
No modulation, transmitter power okay.	1. Microphone A201 or wiring.
1. Voltage on pin 8 of IC4 should be greater than 8 volts.	1. Diode D14. 2. Resistor R85.
2. Voltage on circuit board hole E should be greater than 6 volts.	1. Microphone A201 wiring. 2. Resistors R75 or R76.

Transmitter Problems (Cont'd.)

CONDITION	POSSIBLE CAUSE
3. Voltage on pin 5 of IC4 should be greater than 4 volts.	1. Capacitor C82. 2. Resistors R78 or R81. 3. IC4.
4. Voltage on pin 1 of IC4 should be greater than 4 volts.	1. Capacitors C79, C81, or C83. 2. Resistors R77, R79, or R82. 3. IC4.
5. Voltage on pin 7 of IC4 should be greater than 4 volts.	1. Problem in accessory or wiring. 2. Capacitors C80 or C84. 3. Resistors R83 or R84. 4. IC4.
6. Voltage across resistor R88 should be greater than 3.5 volts.	1. Capacitors C85 or C86. 2. Resistors R86, R87, or R88.
Modulation weak or distorted.	1. Deviation control R88 set wrong. 2. Microphone A201. 3. Diode D14. 4. Capacitors C201 or C202.

MISCELLANEOUS PROBLEMS

CONDITION	POSSIBLE CAUSE
Crystals cannot be set on frequency.	1. Capacitors C63 or C65. 2. Varicap D3. 3. Crystal too far off frequency. 4. Associated circuitry for the crystal in question.
Frequency different between transmit and receive.	1. Offset switch SW203 in wrong position. 2. Capacitors C87, C91, C92, or C93. 3. Transistor Q12. 4. Crystals Y9, Y10, or Y11.
Low local oscillator injection.	1. Check installation of channel crystal(s). 2. Check wiring (red).
1. Voltage on TP2 should be greater than 2 volts.	1. Transistors Q9 or Q10. 2. Diodes D1 or D2. 3. Capacitor C67.
2. Voltage on TP3 should be greater than 1 volt.	1. Transistor Q11. 2. Capacitor C73.
3. No dip in voltage when you adjust coil L26.	1. Capacitors C74, C77, or C78. 2. Coil L26.
Battery does not charge (no light).	1. Open connection between charger and Transceiver. 2. Diode D13. 3. Bare jumper wire not installed on circuit board. 4. Lamp PL301. 5. Transformer T301.
Battery charger pilot lamp extremely bright.	1. Battery cells. 2. Wired for 110 VAC and line cord connected to 220 VAC. 3. Resistor R301.

CHECKING TRANSISTORS AND DIODES

SILICON BIPOLAR TRANSISTORS

To check a transistor accurately, you should use a transistor tester. However, if one is not available, you can use an ohmmeter to determine the general condition of any one of the bipolar transistors in this kit. The ohmmeter you use must have at least 1 volt DC at the probe tips to exceed the threshold of the diode junctions in the transistor you are testing. Most vacuum tube voltmeters meet this requirement.

To check a transistor with an ohmmeter, proceed as follows:

1. Remove the transistor from the circuit.

2. Set the ohmmeter to the R × 1000 range.

3. Connect one of the ohmmeter test leads to the base (B) of the transistor. Touch the other meter lead to the emitter (E) and then to the collector (C). Both readings should be the same, but may be either high or low. If one reading is high and the other low, the transistor should be replaced. (Use the Semiconductor Identification Chart on Page 98 to identify the transistor lead).

4. Interchange the test leads and repeat step 3.

NOTE: In the unusual case when the readings are all low, or all high, no matter which ohmmeter lead is connected to the base, the transistor should also be replaced.

MOSFETs

Insulated gate type MOSFETs are used at Q1, Q2, and Q3 in the receiver circuit and at Q13 in the transmitter circuit. Usually, any defect in these devices is an internal short circuit between the source and one of the gates. You can check them in the circuit with a high impedance voltmeter (10 megohms or higher). An abnormally low source voltage may indicate an internal short circuit.

DIODES

To check a diode, unsolder one end from the circuit board, pull the lead up and out of the circuit board hole, and proceed as follows:

1. Set the ohmmeter to the R × 1000 range.

2. Connect one of the ohmmeter test leads to the lead at the cathode (banded) end of the diode. Connect the other test lead to the other diode lead. Note the meter reading. Then interchange the meter leads and take another reading. One reading should be high and the other low (at least 10:1). If both readings are either high or low, the diode should be replaced.

SPECIFICATIONS

RECEIVER

Sensitivity	.5 μV or less for 20 dB of quieting. .35 μV or less for 12 dB of SINAD*.
Squelch Threshold	.25 μV or less.
Audio Output	1 watt at 10% or less THD.
Operating Frequency Stability	.005% or better.
Adjacent Channel Selectivity	40 dB or greater.
IF Frequency	10.7 MHz.
Usable Bandwidth	$\pm$7 kHz.

TRANSMITTER

Power Output	2 watts or more at 12.5 VDC; adjustable.
Deviation	5 kHz or less; adjustable.
Spurious Output	$-$50 dB or greater at 2 watts output.
Stability	.005% or better.
Oscillator Frequency	Approximately 15 MHz.
Multiplication Factor	$\times$ 9.
Modulation	Frequency.
Transmitter Offsets	0 (simplex), $-$600 kHz, +600 kHz with crystals supplied.

$$*\text{SINAD} = \frac{\text{Signal + noise + distortion}}{\text{Noise + distortion}}$$

GENERAL

Frequency Coverage	143.5 to 148.5 MHz (unit will meet specifications ± 1 MHz from the alignment frequency within this range).
Operating Temperature	+10°F to +120°F (−12°C to +47°C).
Operating Voltage	12.5 VDC nominal.
Number of channels	8.
Antenna impedance	50 Ω.
Speaker Impedance	8 Ω.
Size (overall)	Transceiver (less antenna): 9-1/8″ high × 3-5/16″ wide × 1-7/8″ deep (23.2 × 8.4 × 4.8 cm). Charger: 3-1/16″ high × 4-1/16″ wide × 3-3/4″ deep (7.8 × 10.3 × 9.5 cm).
Weight	Transceiver (including batteries): 2 lb. (900 g). Charger: 8 oz. (220 g).

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (Illustration Booklet, Page 14) and the Schematic (fold-in) while you read this "Circuit Description." The part numbers are arranged in the following groups to help you locate specific parts on the schematic, circuit board, case, and battery charger:

1-199	Parts on the circuit board.
201-299	Parts on the case.
301-399	Parts in the battery charger.

GENERAL

Transistor Q9 and its associated circuitry form the local oscillator, which is the heart of the Transceiver. This oscillator supplies signals for both the transmitter and receiver circuits and enables you to use the same channel crystal for both functions. The signal at the output of Q9 is three times the crystal frequency, which is between 14.75 and 15.31 MHz. With the 15.1377 MHz crystal supplied (for 146.94 MHz operation), the output of this circuit is 45.4133 MHz. Multiplier transistor Q10 triples this signal again to form the 136.24 MHz signal which transistor Q11 amplifies and couples to the receiver and transmitter circuits.

RF amplifier transistors Q1 and Q2 in the receiver section amplify the signals at the antenna before they are mixed, by transistor Q3, with the local oscillator signal to provide the 10.7 MHz IF signal.

Matched filters FL1 and FL2 couple the IF signal to transistor Q4, which amplifies the signal before it is detected (changed into an audio signal) by integrated circuit IC1.

Transistors Q5 and Q6 and IC3A form the squelch circuit, which keeps the receiver quiet when no signals are being received. Control R201 (Squelch) allows you to adjust the operation of this circuit from a completely unsquelched condition to a tightly squelched condition.

Integrated circuit IC2 amplifies the audio signals from the detector to a sufficient level to drive the speaker. Control R202 (Volume) allows you to set the audio level to the desired loudness.

Transistor Q7 and integrated circuit IC3B form a battery saver circuit to reduce power consumption during periods when the receiver is on, but not receiving any signals. Q7 also removes B+ from the receiver during the transmit mode.

In the transmitter section, integrated circuit IC4 (A and B) amplifies audio signals at the microphone before they are applied to varacter diode D3. This causes the local oscillator signal to be frequency modulated as required for proper operation.

Offset oscillator transistor Q12, which operates at the frequency of the crystal switched in by switch SW203 (offset), supplies the proper signal to the transmitter for the desired mode of operation. Transistor Q13 mixes this signal with the frequency modulated local oscillator signal to produce the actual transmitter operating signal between 143.5 and 148.5 MHz.

The signal from the mixer is amplified by transistors Q14, Q15, Q16, and Q17 before it is coupled through a low-pass filter to the antenna.

Transistor Q8 supplies B+ to the transmitter during the transmit mode.

The following sections explain the operation of each circuit in more detail.

LOCAL OSCILLATOR AND MULTIPLIER CIRCUITS

The channel crystal in this Transceiver operates at 15 MHz and must be multipled by nine before it forms the actual local oscillator signal. Coil L13, which is adjustable, and capacitor C52 allow you to adjust the frequency of the channel crystal to the correct frequency. Coil L12, diode D3, oscillator transistor Q9, and capacitors C63 and C65 provide the proper loading for the crystal. Coil L22 and capacitor C64 are tuned to the third harmonic of the crystal and provide the first × 3 multiplication of the crystal.

Capacitors C66, C67, and C68, together with coil L23, provide filtering for the 45 MHz signal from the oscillator before it is applied to transistor Q10. Q10 is tuned to the third harmonic of this signal and provides the second × 3 multiplication. Coil L24 and capacitors C71 and C73 filter the resulting 135 MHz signal before it is amplified by transistor Q11. The signal is again filtered by coil L26 and capacitor C74 before it is coupled to the receiver via capacitor C77, and to the transmitter via capacitor C78.

Zener diode D4 regulates the oscillator operating voltage to maintain frequency stability with varying battery voltages.

In the transmit mode, a signal from the modulation circuit (to be explained later) is applied to varacter diode D3. This causes the local oscillator to be frequency modulated.

RECEIVER CIRCUIT

RF Amplifiers

Transistors Q1 and Q2, and their associated circuitry, form the two RF amplifiers in the receiver. This results in a 3-section filter which, when properly tuned, provides 40 db of image rejection and a total of 28 dB of power gain.

Capacitors C1, C2, and C4, together with coil L1, form the first filter section and also provide impedance matching for the first RF amplifier.

Capacitors C8 and C9 and coil L2 form the second filter section and provide impedance matching for the second RF amplifier.

The third filter is formed by coil L3 and capacitors C13 and C15. These components also provide impedance matching for mixer transistor Q3.

Mixer and IF Stages

The amplified signal from the RF amplifier is applied to gate 1 of mixer transistor Q3. The local oscillator signal from transistor Q11 is also applied to Q3 via gate 2. The resultant 10.7 MHz IF signal is tuned by coil L4 and capacitor C18, which provide the proper drive impedance for the 4-pole monolithic filter formed by FL1 and FL2.

The 4-pole filter is tuned to the 10.7 MHz IF signal and has a 3 dB bandwidth of at least 15 kHz. The ultimate attenuation of the filter is greater than 75 dB. Coil L6, capacitors C21 and C22, and IF amplifier transistor Q4 properly terminate this filter.

Neutralization capacitor C23 and collector resistor R19 help stabilize the gain of Q4. Coil L7 and capacitors C25 and C27 match the impedance of the IF amplifier to integrated circuit IC1.

IC1, which is an IC subsystem, performs the following functions:

IF amplification.

Frequency discrimination.

Logarithmic level detection.

Audio preamplification.

Two-pole monolythic filter FL3 provides phase shifting for the frequency discriminator function of the IC, and the discriminator peaks are ±20 kHz from the center frequency. Resistor R22 and coil L10 provide the correct drive impedance for this part of the circuit, while resistor R23 and coil L11 provide the correct termination imepdance.

Capacitors C28, C31, C33, C34, C35, C36, and C39 provide RF bypassing for IC1 while resistor R24 and capacitors C37 and C38 shape the frequency response of the audio signal. Resistor R26 heavily loads the signal level detector output, pin 13 of the IC, to minimize the effects of the squelch circuits (Q5).

Squelch and Battery Saver Circuits

Many transceivers use a noise-derived squelch system which is based on the amount of (or lack of) high-frequency noise in the audio bandwidth.

Because the carrier-derived squelch system is inherently a faster system, it was chosen for use in this Transceiver. This sytem is based on the detected RF level in the IF amplifier passband and results in a squelch closing (squelch tail) of about 30 milliseconds.

Level-shifter transistor Q5 is the beginning of the squelch signal. This transistor takes the low voltage, relative signal-strength signal (from IC1) and adds it to the setting of the Squelch control, R201. The resulting voltage is compatible with the squelch decision circuit formed by IC3B. Capacitor C47 limits the squelch bandwidth while resistors R32 and R33 set the decision point voltage.

When the voltage on IC3B pin 5 exceeds the set voltage at pin 6, the high gain of the amplifier will cause the output to change from a low-latched state to a high-latched state. Resistor R34 provides a small amount of hysteresis to keep the squelch from toggling on and off at low signal levels.

The output from IC3B is applied to transistor switch Q6, which applies a cutoff voltage to IC2 during the squelch mode and is an open circuit during the receive mode. A voltage from IC3B is also applied via diode D5 to the battery saver oscillator, formed by IC3A, to latch it in the receive mode.

The battery saver oscillator is a pulse generator which operates at a repetition rate of about 8 Hz. This allows for the acquisition of an incoming signal in a reasonable time (60-200 milliseconds). The pulse generation is accomplished by applying positive feedback, through resistor R41, around the integrator formed by capacitor C48 and resistors R42 and R43. R42 and C48 determine the time constant for the output at pin 1 in the high state (about 110 milliseconds) while R43, which is in parallel with R42 and C48, determines the low state (10 milliseconds.)

The output at pin 1 of IC3A is applied to PNP switch Q7, which keys the voltage to the receiver section on and off. During the transmit mode, a voltage from the transmitter supply line is applied, via diodes D7 and D8, to turn off the audio amplifier and to latch the pulse generator output high (receiver supply line off.)

Audio Amplifier

Integrated circuit IC2 forms the audio amplifier. This IC is capable of providing 2 watts of output and has an "open loop" voltage gain of 75 dB. The circuit, however, was designed to trade off some gain and output power capability for better stability and low distortion.

The IC has internal negative feedback while resistor R31 and capacitor C49 set the basic gain of the stage. Actual audio output is limited to about 1-1/4 watts before clipping begins to occur.

Capacitor C42, resistor R24, and capacitors C37 and C38 shape the audio response and provide the proper de-emphasis with extra low-pass filtering above 2.5 kHz.

Audio output from the IC is coupled through capacitor C46 to the speaker and earphone jack. The reactance of this capacitor at 300 Hz is equal to the speaker's 8-ohm impedance.

Capacitors C44 and C45 provide the proper bypassing at both audio and high frequencies. High frequency bypassing is necessary on this particular IC due to the high-frequency gain that is inherent in the device.

TRANSMITTER

Modulation Circuit

A single integrated circuit, which contains two operational amplifiers (IC4A and IC4B), forms the modulation circuit. These amplifiers, along with the associated components, perform the following functions:

Microphone preamp.

Pre-emphasis.

Tone input summation.

Limiting.

Low-pass filtering.

IC4A amplifies the low-level audio signals present at the microphone by a factor of approximately 48. The voltage divider on its input formed by resistors R74 and R77, however, holds the total voltage gain of the stage to about 32. A typical 8 mV (RMS) signal from

the microphone would produce a 260 mV (RMS) signal at the output of this amplifier pin 1.

NOTE: Resistor R79 is a user selected part. The maximum gain at IC 4A is with a 220 kΩ resistor. If you use one of the other two resistor values the approximate gain reduction is as follows:

120 Ω = 5 dB reduction
68 kΩ = 10 dB reduction

When an external microphone is used with this Transceiver, the internal microphone must be turned off. This is accomplished by shorting the supply voltage for the internal microphone to ground when you plug in the external microphone. Resistor R76 limits the current to a low level.

Capacitor C80 couples the preamplified signal from IC4A to IC4B. This capacitor also provides a 6 dB-per-octave pre-emphasis while resistor R83 limits the high frequency corner of the emphasis to about 8 kHz. The reference voltage at pin 5 is offset from the midpoint of the supply voltage to provide better symmetry of the modulated signal. A 260 mV (RMS) 1 kHz signal at pin 1 of this IC will cause the second stage to be in full limiting (approximately 5 volts peak-to-peak square wave) at pin 7.

Additional input points are included so you can connect the auto-patch encoder and tone accessories. These points bypass the pre-emphasis circuits and ensure a flat bandwidth up to 2800 Hz. Resistors R86 and R87, together with capacitors C85 and C86, form a low-pass filter which also has a high-frequency cutoff of approximately 2800 Hz.

Zener diode D14 regulates the voltage to IC4 and ensures a constant limited output which is independent of the battery voltage.

Transmitter Offset Oscillator

Transistor Q12 and the associated circuitry form a simple crystal oscillator which provides the proper frequency offset for the transmitter.

Offset switch SW203 selects the offset crystal (Y9, Y10, or Y11), by forward biasing diode D15, D16, or D17 respectively. Resistors R92, R93, or R94 back bias the two unused crystals.

Proper crystal loading is provided by capacitors C91, C92, and C93. No voltage regulation is necessary in this circuit since the frequency shifts less than 15 Hz at ±15% voltage extremes.

Transmitter Mixer/Amplifier Chain

Transistor Q13 forms the beginning of the actual transmitter RF signal. Transmit mixer transistor Q13 combines the signals from the offset oscillator (Q12) and the local oscillator (Q11) to produce a signal between 143.5 and 148.5 MHz.

The bandpass filter formed by coils L31 and L32, together with capacitors C96, C97, C99, and C101, selects the high product from Q13. This ensures that transmit predriver transistor Q14 amplifies the correct signal from the mixer.

Coils L34 and L35, and capacitors C103, C105, C106, and C107, form another bandpass filter for the amplified signal before it is amplified again by transistor Q15. The resulting signal is then filtered again by coil L36 and capacitors C111 and C113 before it is coupled to driver transistor Q16.

The signal from Q16, which is about 150 milliwatts, is coupled to power amplfier transistor Q17. Control R114 provides a method of controlling the output power from this stage to conserve battery power drain. When control R114 is set for full power, Q17 amplifies the 150 milliwatt signal from the driver to about 2.5 watts.

Test points TP4 through TP8 provide sensitive adjustment connections so you can easily align the transmitter section for the best performance.

Low Pass Filter

A low-pass filter (formed by coil L41 and capacitors C123, C124, C125 and C126) reduces harmonics in the transmitter signal and also protects the receiver from high power UHF signals. Coil L41 and capacitor C124 are tuned to the second harmonic (approximately 292 MHz) and provide a high degree of the attenuation at this harmonic.

Transmit (PTT) Switch

Transistor Q8 is the heart of the transmit/receive switch circuitry. When you push the PTT switch (SW204), base current is applied to Q8 via resistor R48. This causes Q8 to conduct and apply 12.5 volts from the battery to the transmitter power bus (orange wires). The voltage also is applied via D7 to IC2 which causes it to be in a squelched condition. Voltage is applied via D8 to the battery saver circuit and removes voltage from the receiver circuits. Resistor R47 provides a low resistance path between the base and emitter to ensure turn off at high temperatures.

Antenna Switching

Diodes D6, D9, and D11 electronically switch the antenna between transmit and receive.

In the receive mode, voltage is present on the receiver supply line. This voltage forward biases diodes D6 and D9 through resistors R5 and R125. Since these diodes are turned on, they also pass the RF signals from the antenna to the receiver input circuits (Q1). The voltage across R125 reverse biases diode D11 (because there is no voltage present on the transmitter supply line), which reduces the coupling between the antenna and the transmitter circuits.

In the transmit mode, the voltage present on the transmitter supply line forward biases diode D11 through resistor R125. This allows the RF signals from the transmitter to be coupled to the antenna. Since there is no voltage on the receiver supply line at this time, diodes D6 and D9 are reverse biased and prevent the RF signals from being coupled to the receiver circuits.

BATTERY CIRCUIT

Ten NICAD cells form the battery pack, which is fused from the rest of the Transceiver by a miniature, 2-ampere, plug-in fuse.

Diode D13 rectifies the AC coming from the battery charges and also protects the batteries in the event the Transceiver is set on a metal surface.

NOTE: If you charge the batteries from a source other than the charger supplied with this kit, be sure to limit the current flow to less than 80 milliamperes.

BATTERY CHARGER

The battery charger supplies an AC voltage to the Transceiver via the contacts on the bottom of the Transceiver.

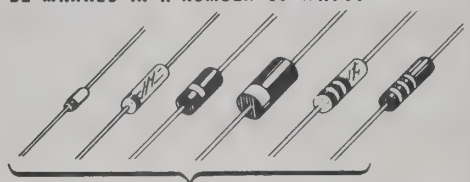
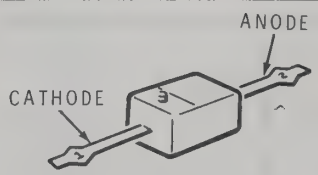
Resistor R301, pilot lamp PL301, and the secondary resistance of transformer T301 provide the necessary current limiting required by the batteries. The charging current (nominally 40 milliamperes) is also dependent on the condition of the batteries, the AC line voltage, and component tolerances.

Capacitor C301 is included with the kit so you can use the charger on a 220 VAC line.

Transformer T301 has a current limited secondary and does not require a fuse.

SEMICONDUCTOR IDENTIFICATION CHARTS

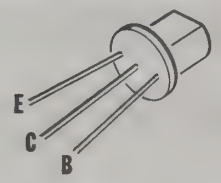
DIODES

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMPONENT NUMBER	LEAD CONFIGURATION
56-26	1N191	D8, D18	IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.  BANDED END
56-54	VRS-5A	D14	
56-56	1N4149	D1, D2, D5, D6, D7, D9, D10, D12	
56-97	1N3017	D4	
56-646	BA-244	D11, D15, D16, D17	
57-27	1N2071	D13	
56-648	MV109	D3	

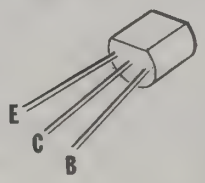
TRANSISTORS

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMPONENT NUMBER	BASING DIAGRAM
417-118	2N3393	Q5	A or B
417-154	2N2369	Q16	C
417-201	X29A829	Q6, Q7	A or B
417-274	40673	Q1, Q2, Q3, Q13	D
417-819	MJE171	Q8	F
417-887	MPSH10	Q4, Q9, Q12	H
417-912	MRF237 OR SD1127	Q17	G
417-934	2N5770	Q10, Q11, Q14, Q15	E

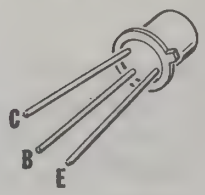
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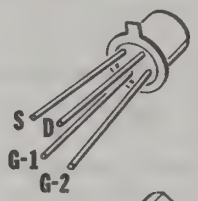
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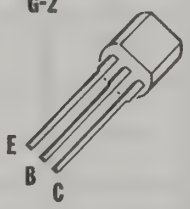
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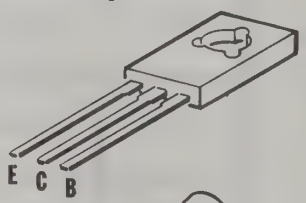
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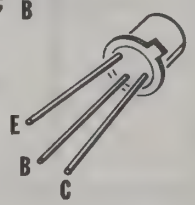
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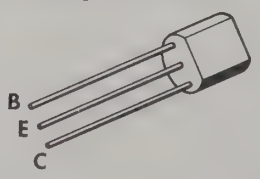
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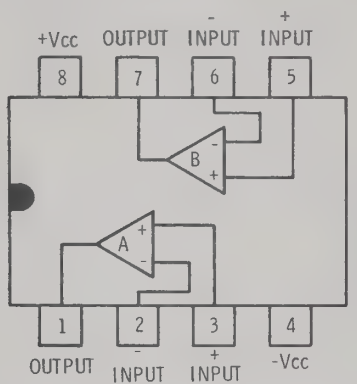
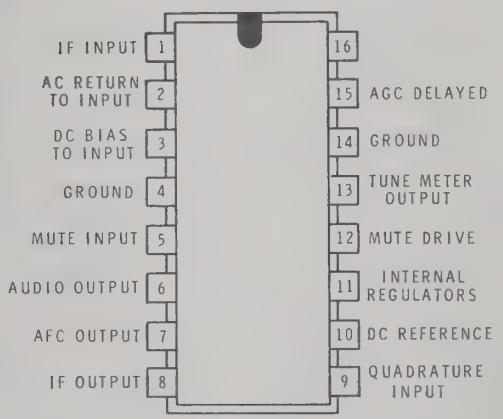
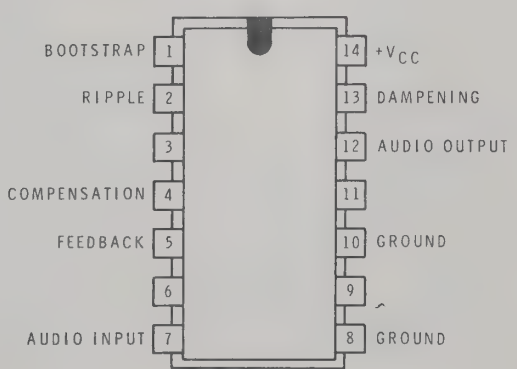
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H



INTEGRATED CIRCUITS

HEATH PART NUMBER	MAY BE REPLACED WITH	CIRCUIT COMPONENT NUMBER	IDENTIFICATION TOP VIEW
442-21	MC1458	IC3, IC4	
442-92	CA3089	IC1	
442-610	TBA820L	IC2	

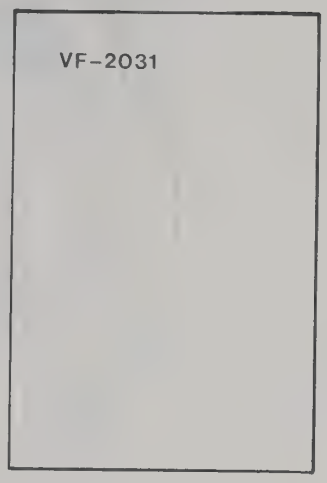


N BOOKLET

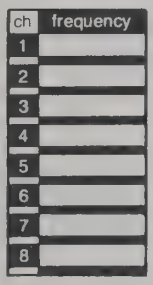
PARTS PICTORIAL

Part of 595-2085-02

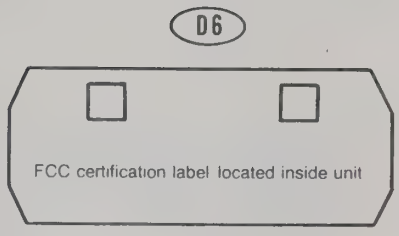
D5



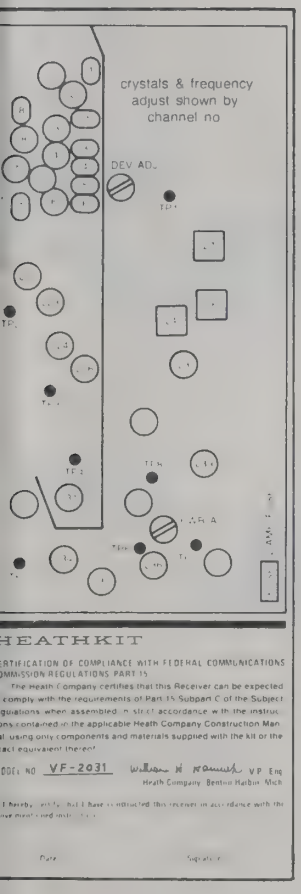
D4



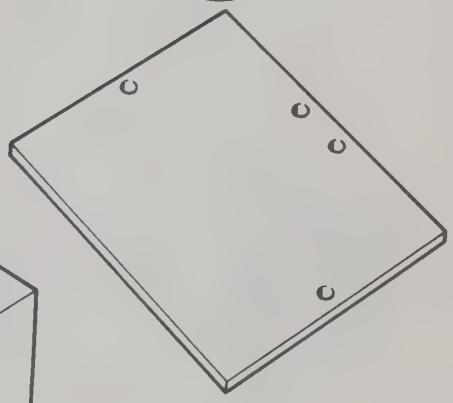
D6



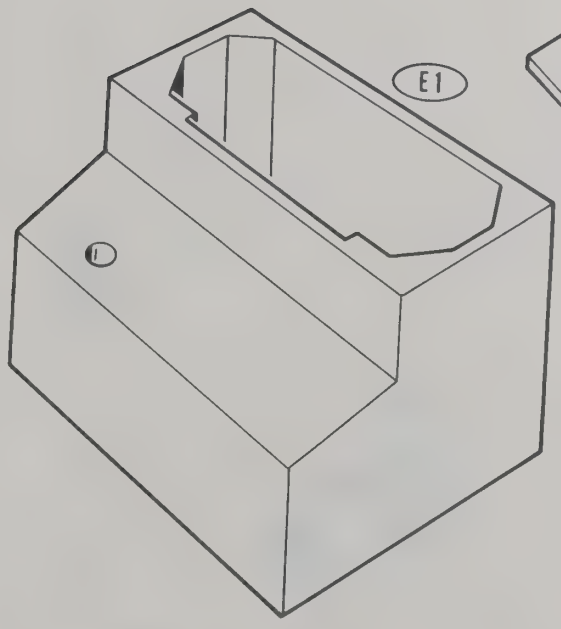
D7



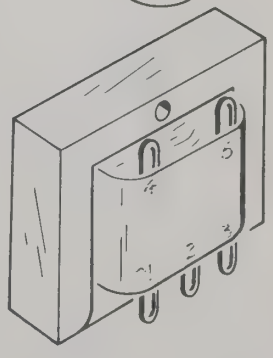
E2



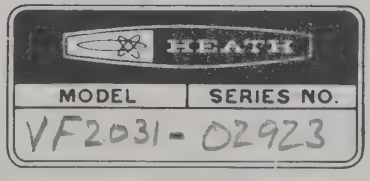
E1



E3



D8



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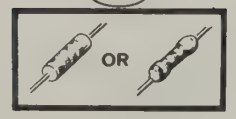


ILLUSTRATION BOOKLET

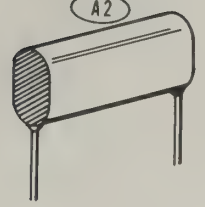
Part of 595-2085-02

BATTERY CHARGER PARTS PICTORIAL

A1



A2



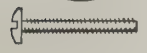
A3



B1



B2



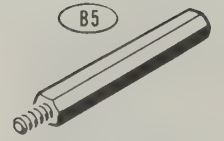
B3



B4



B5



C1



C2



C3



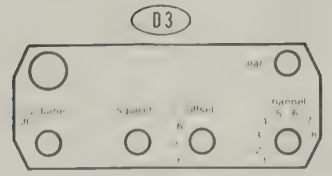
D1



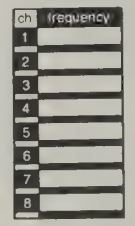
D2



D3



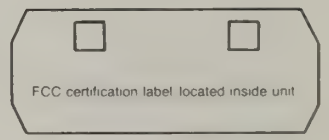
D4



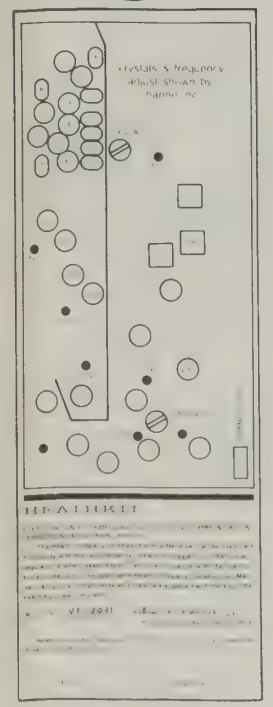
D5



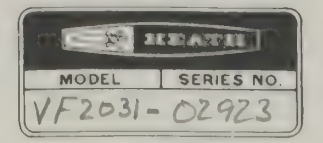
D6



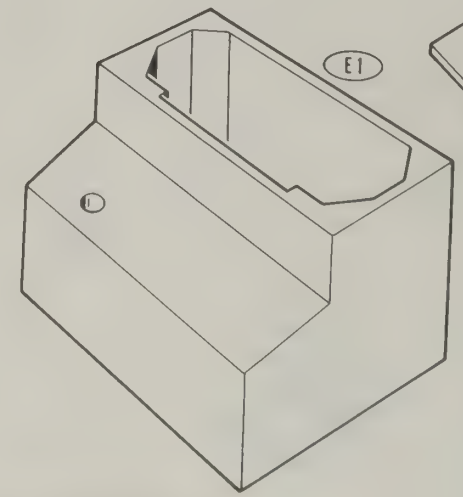
D7



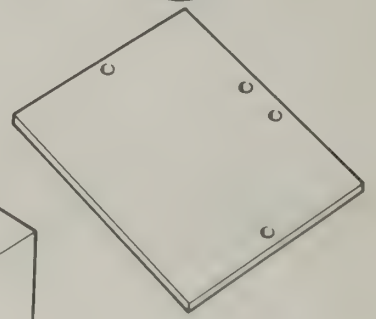
D8



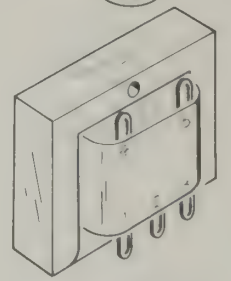
E1



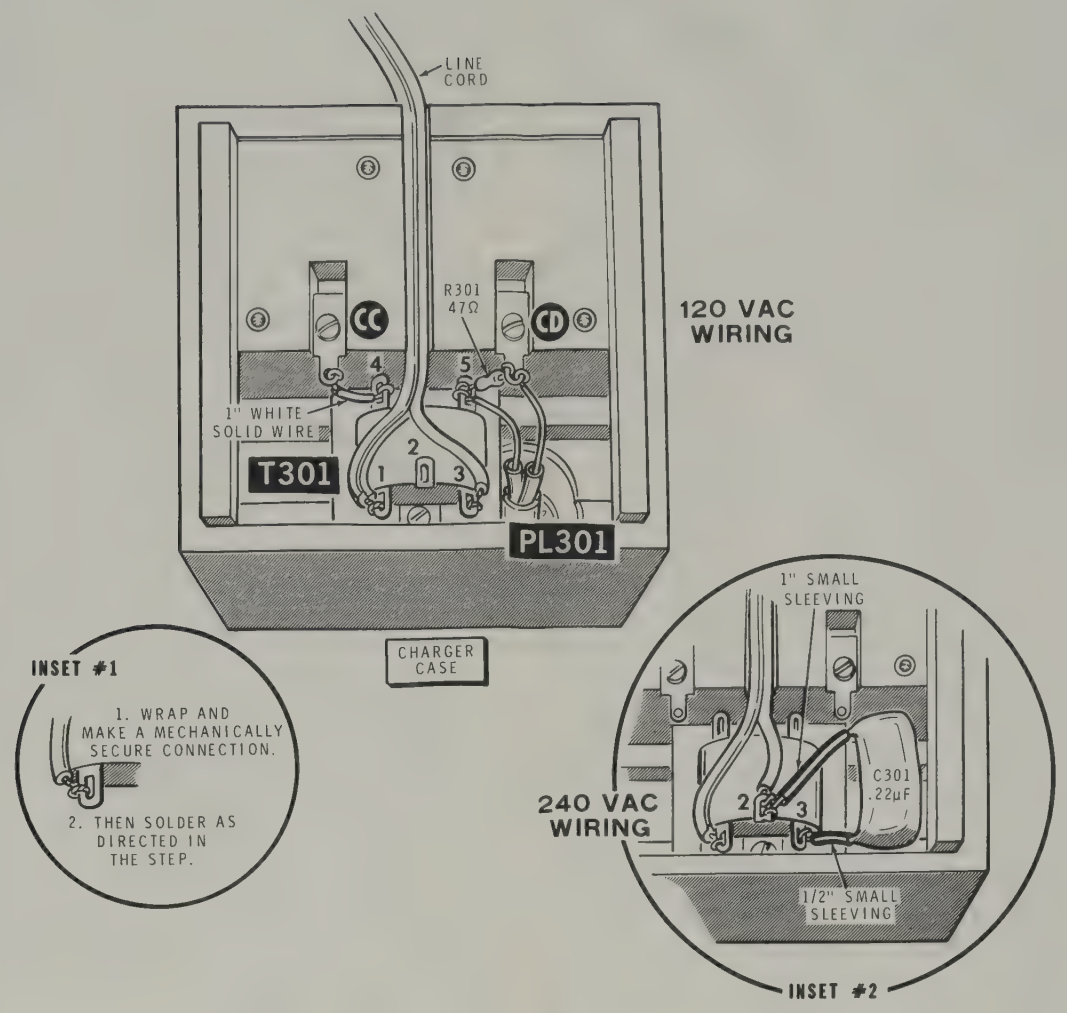
E2



E3



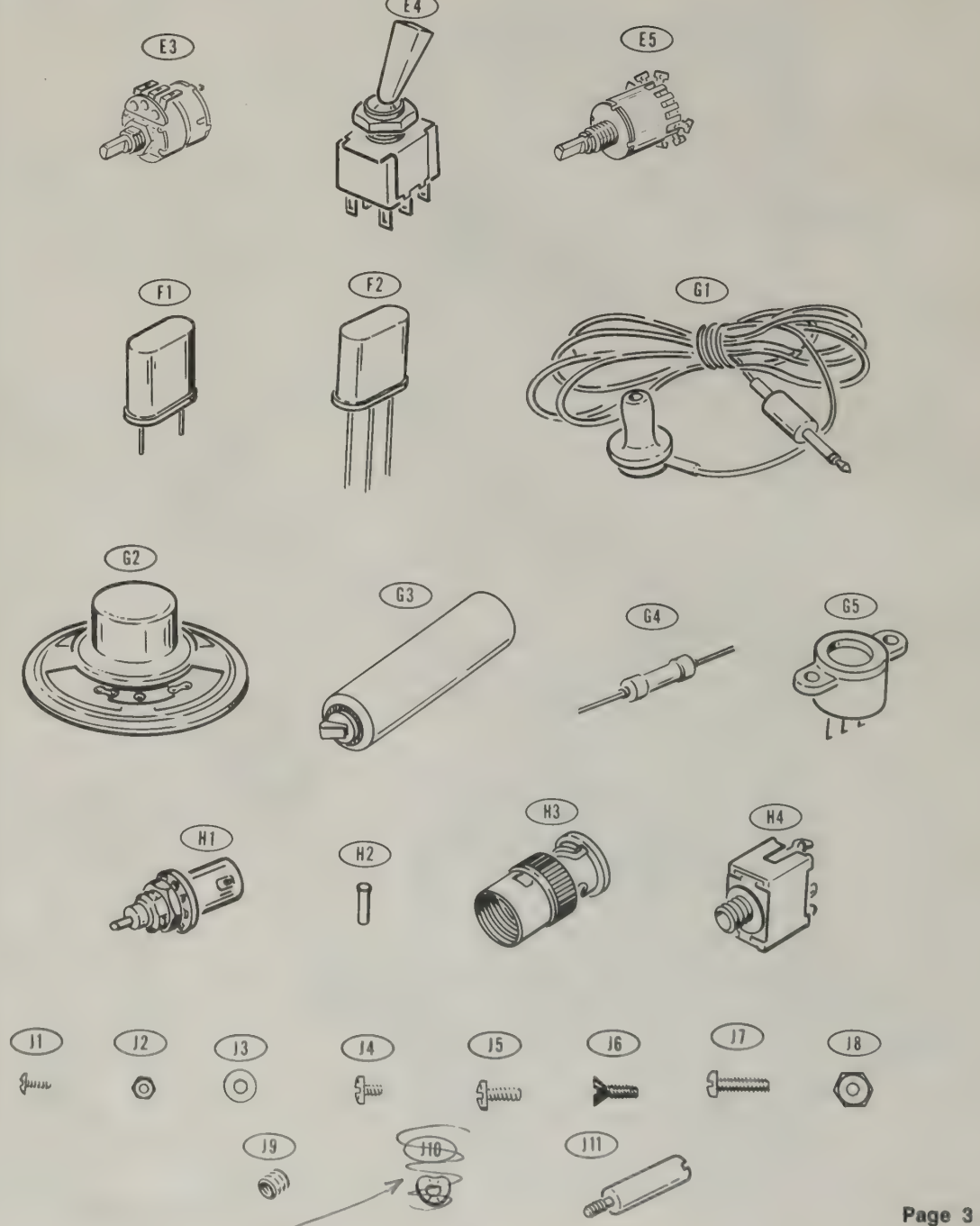
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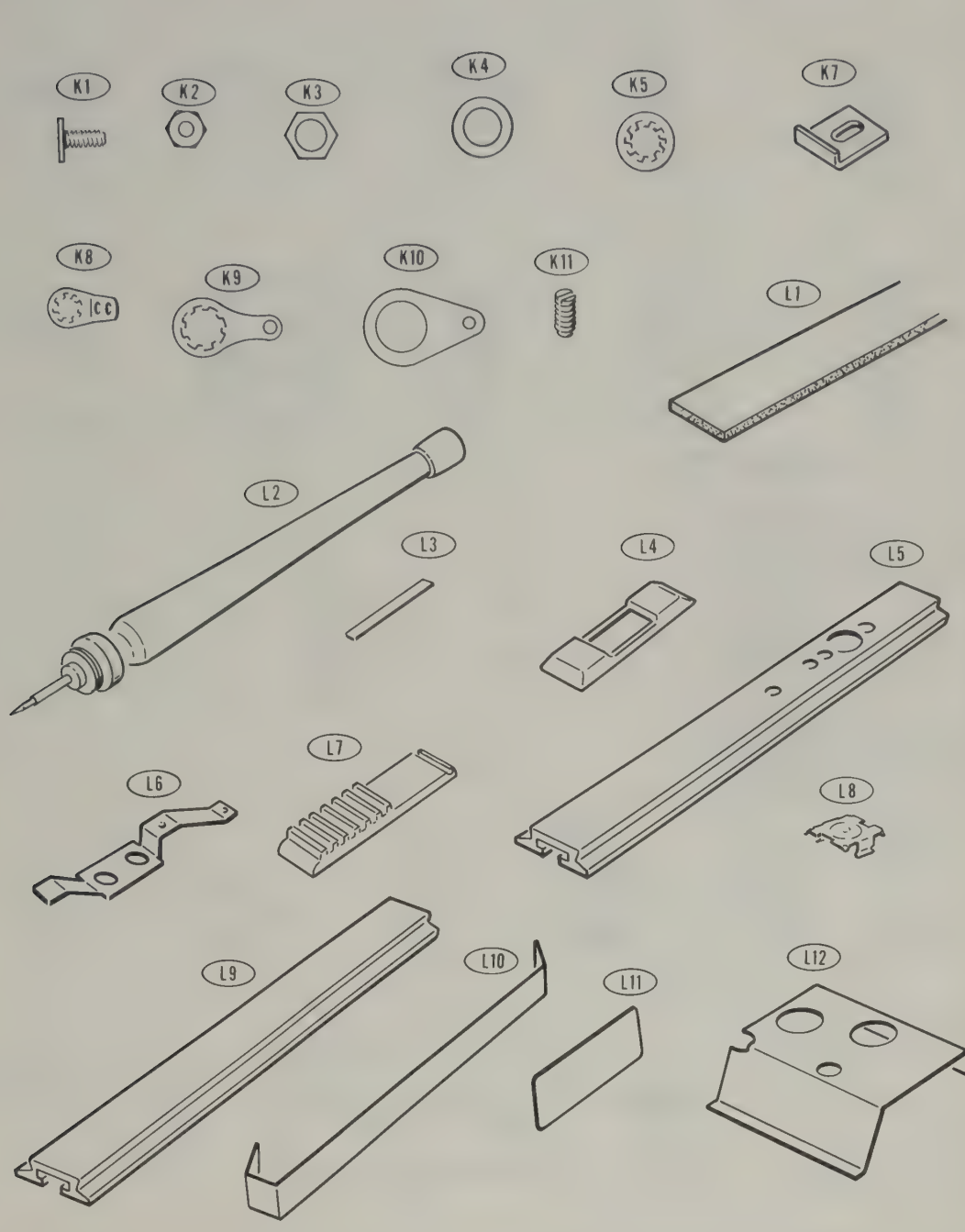
PICTORIAL 1-2

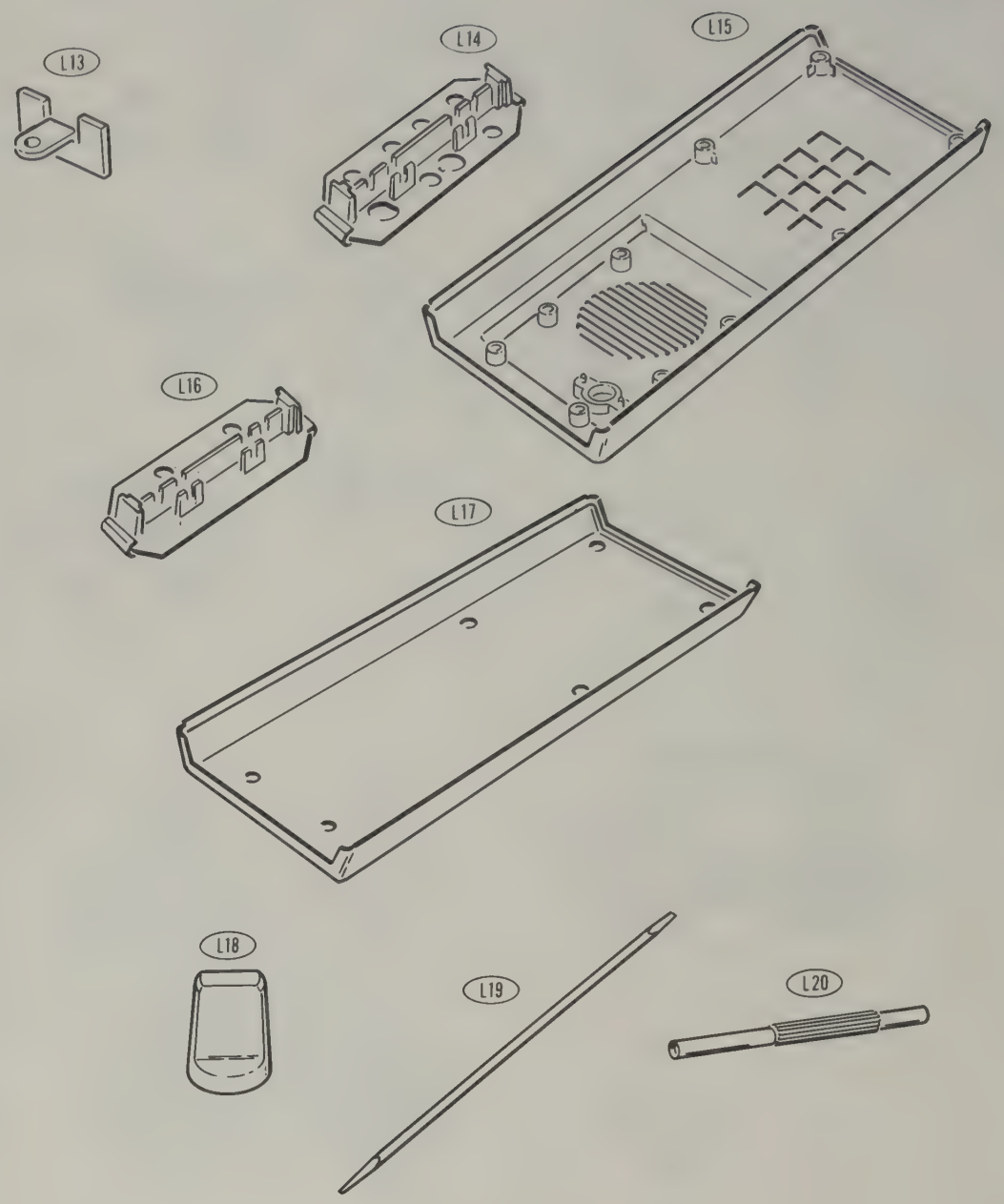
TRANSCEIVER PARTS PICTORIAL

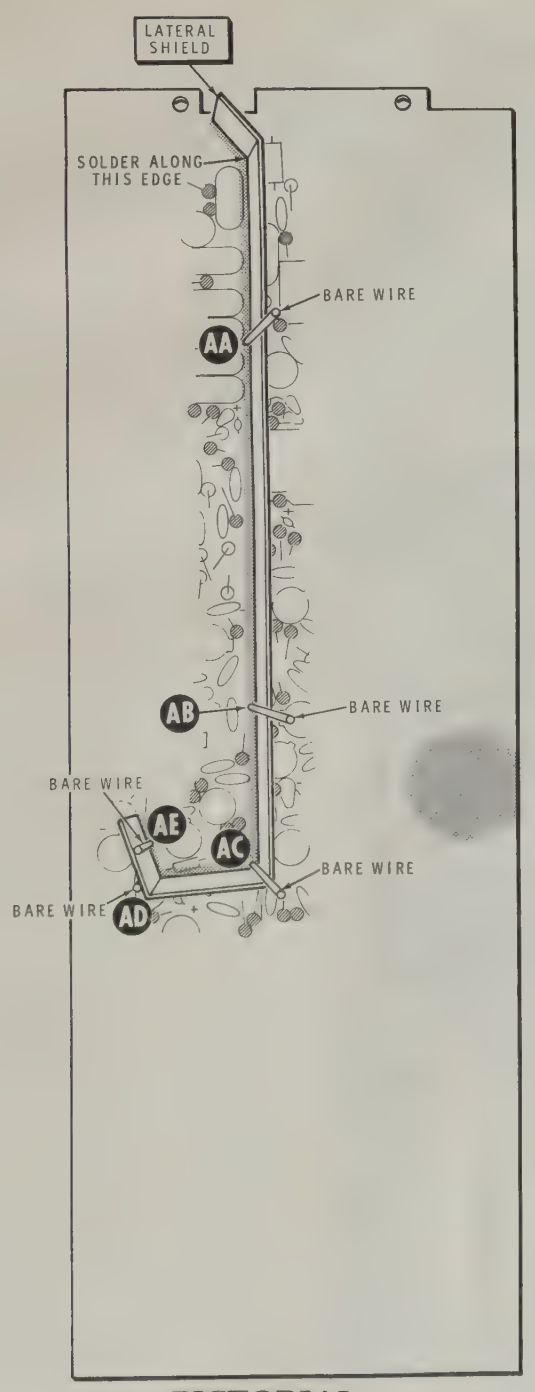




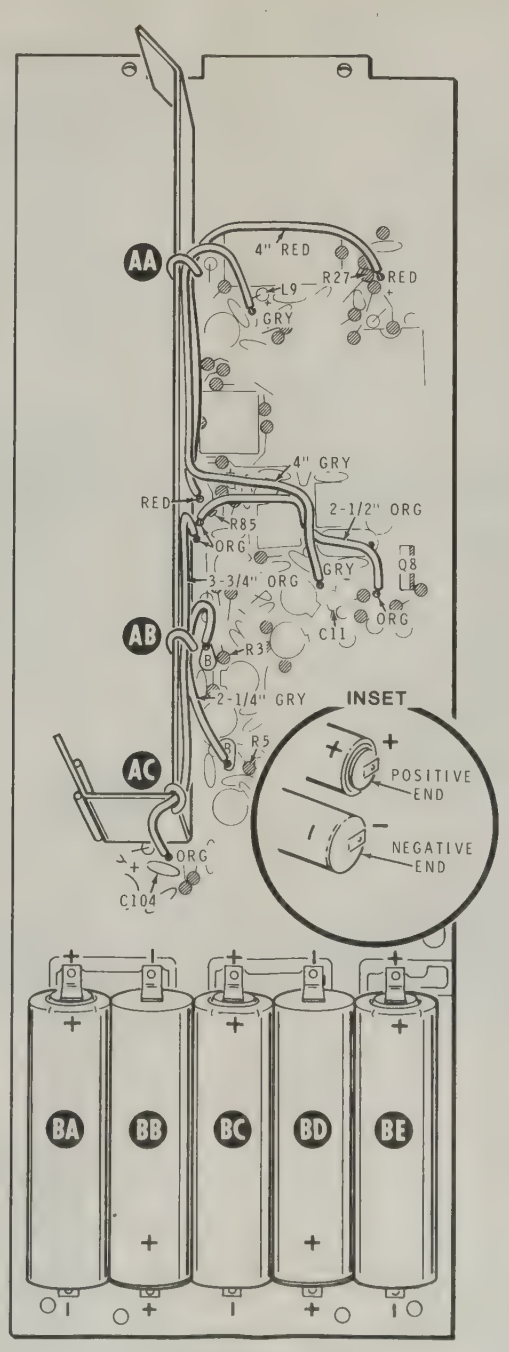
Transceiver Parts Pictorial (Cont'd.)



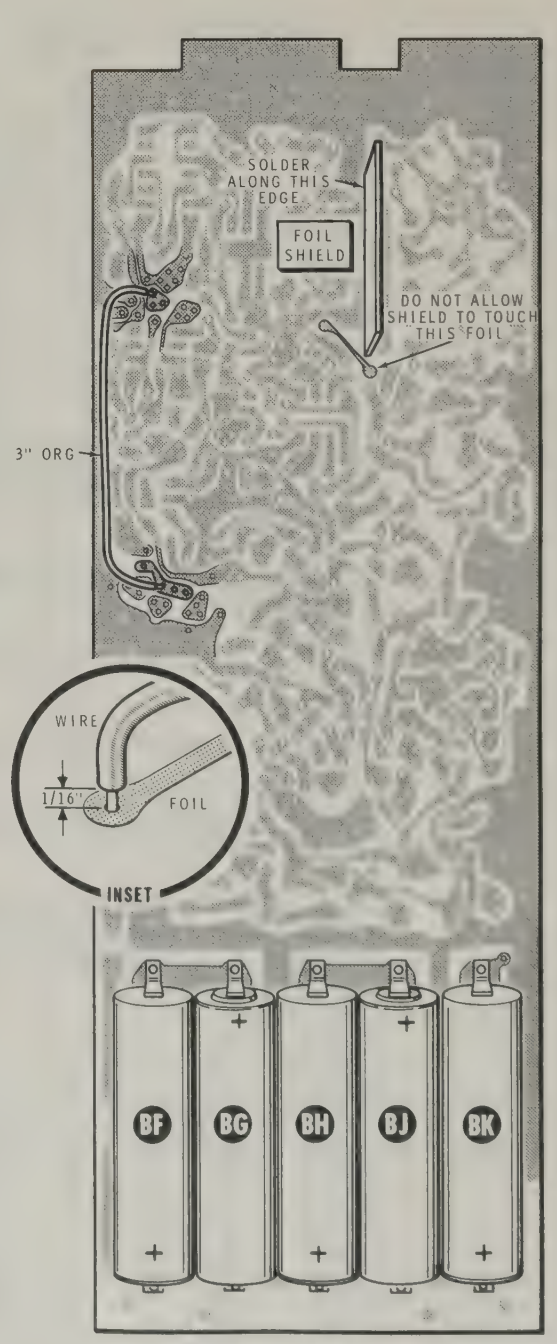




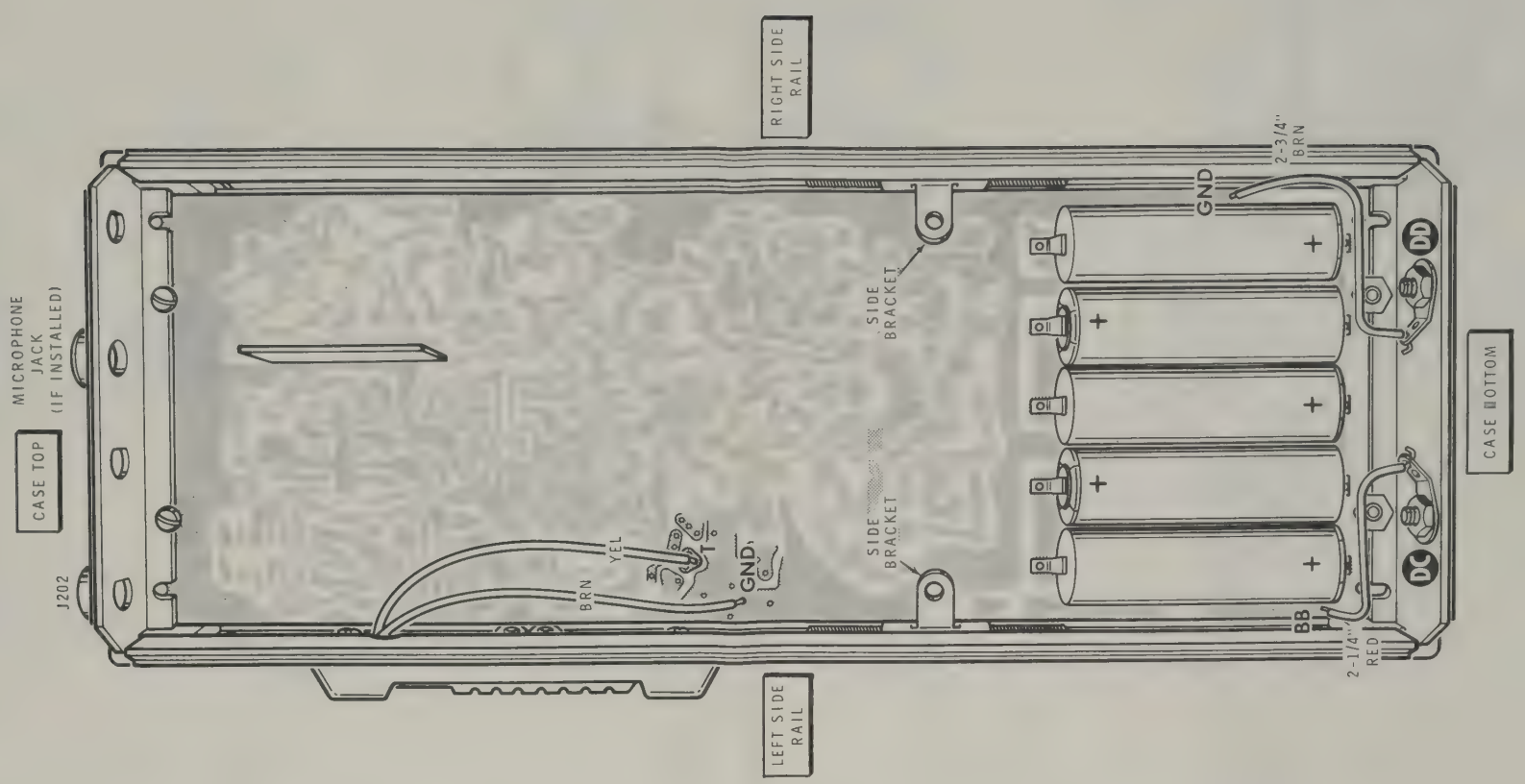
PICTORIAL 2-2



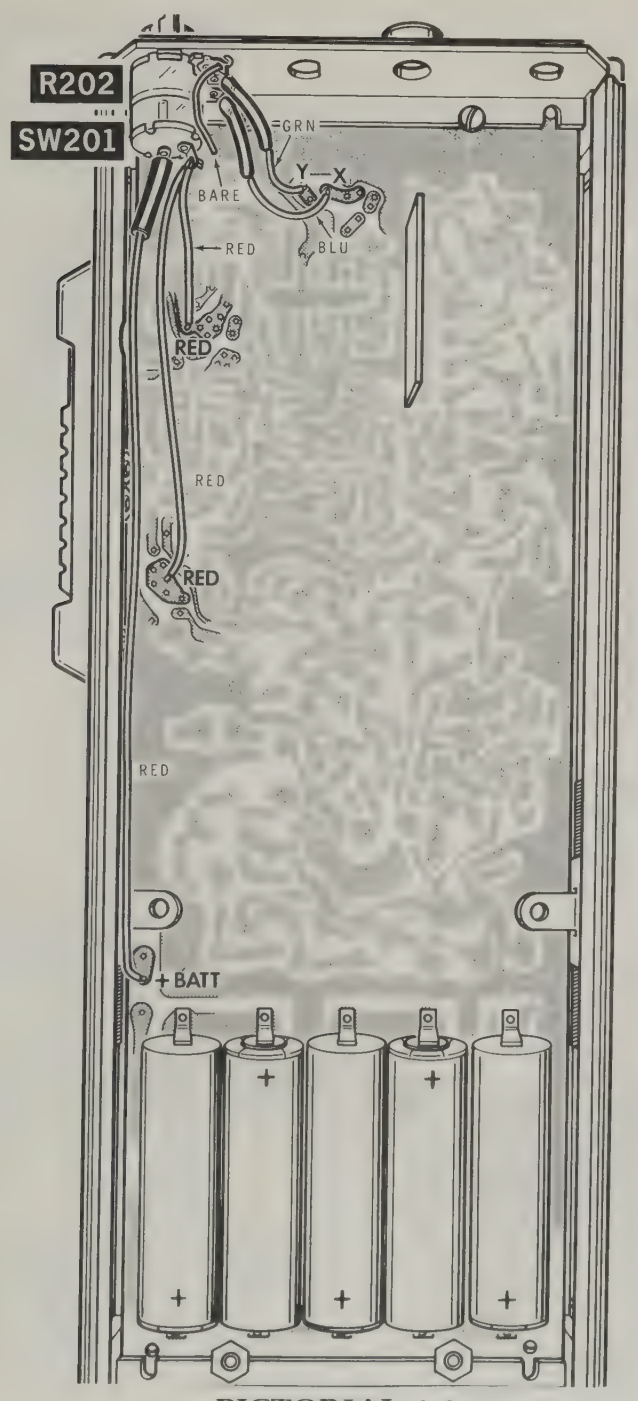
PICTORIAL 3-21



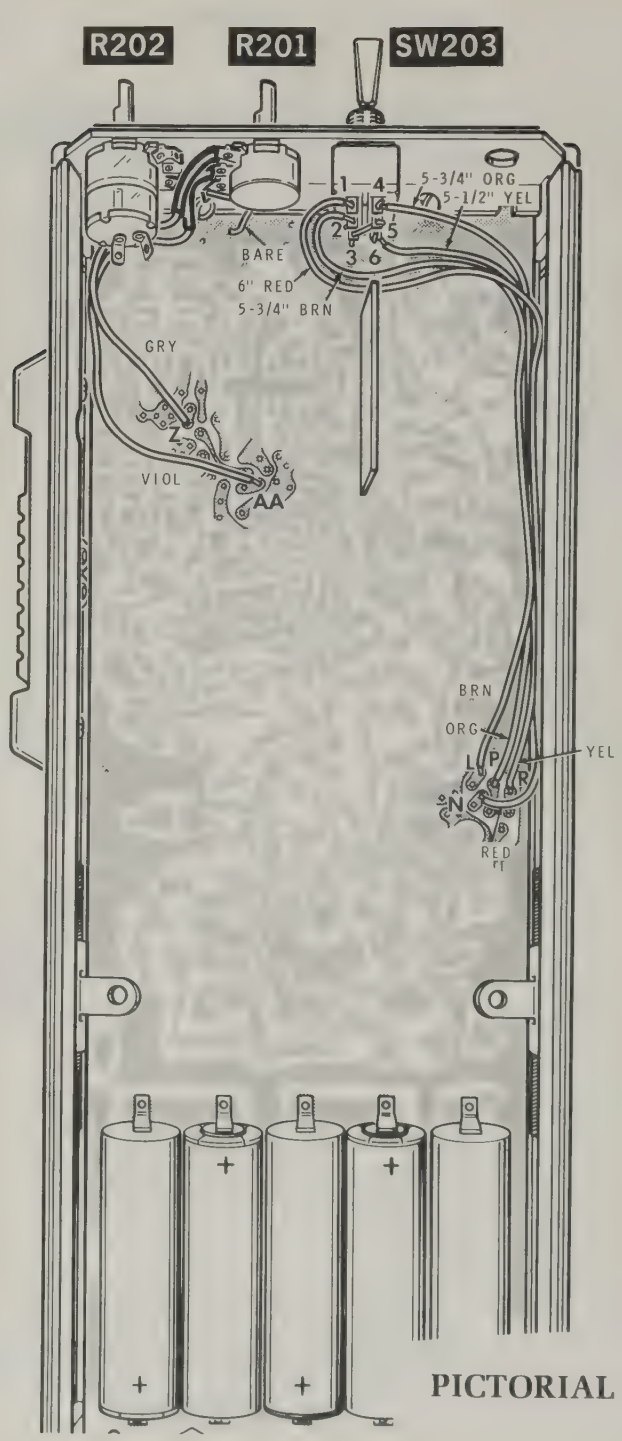
PICTORIAL 3-22



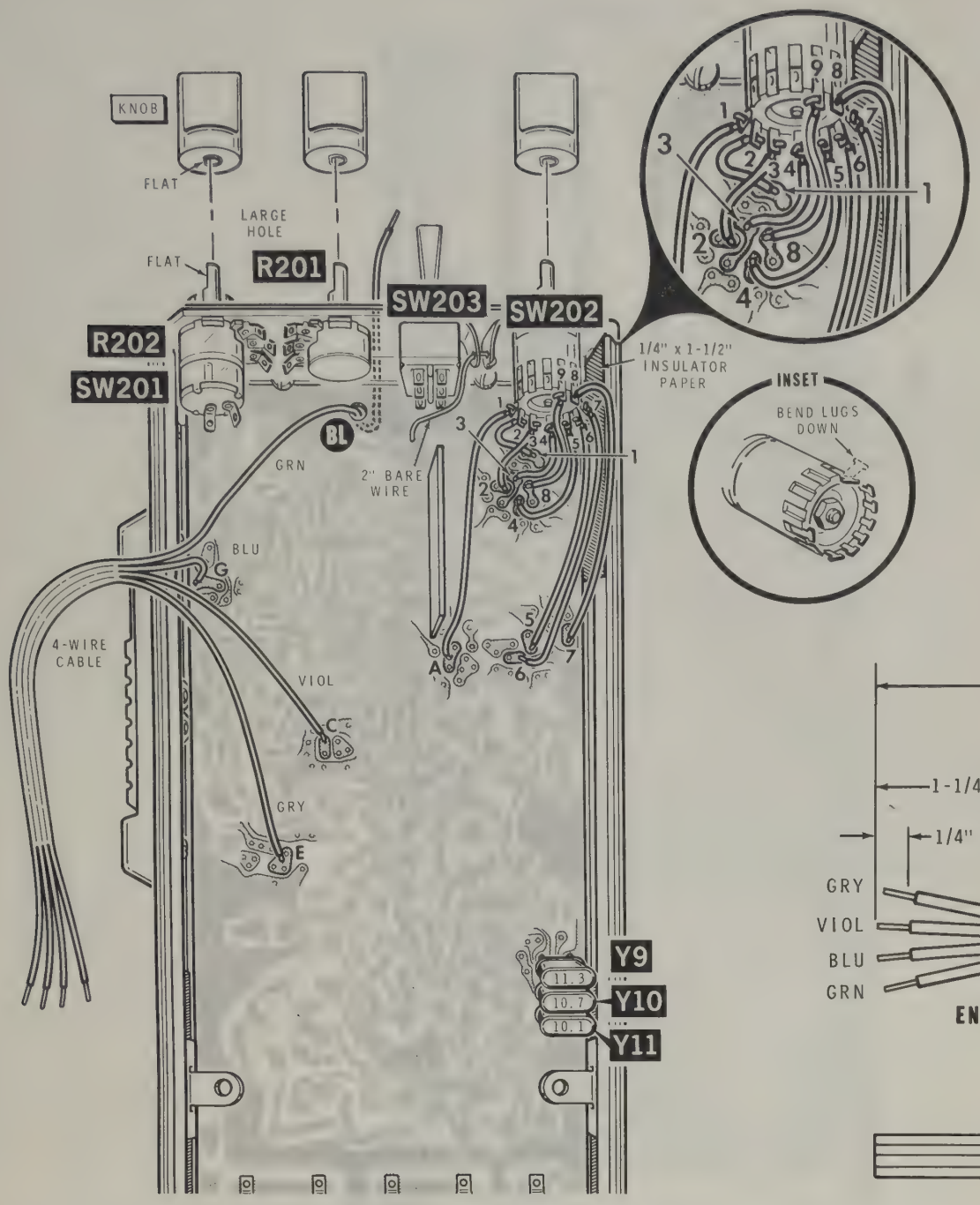
PICTORIAL 4-1



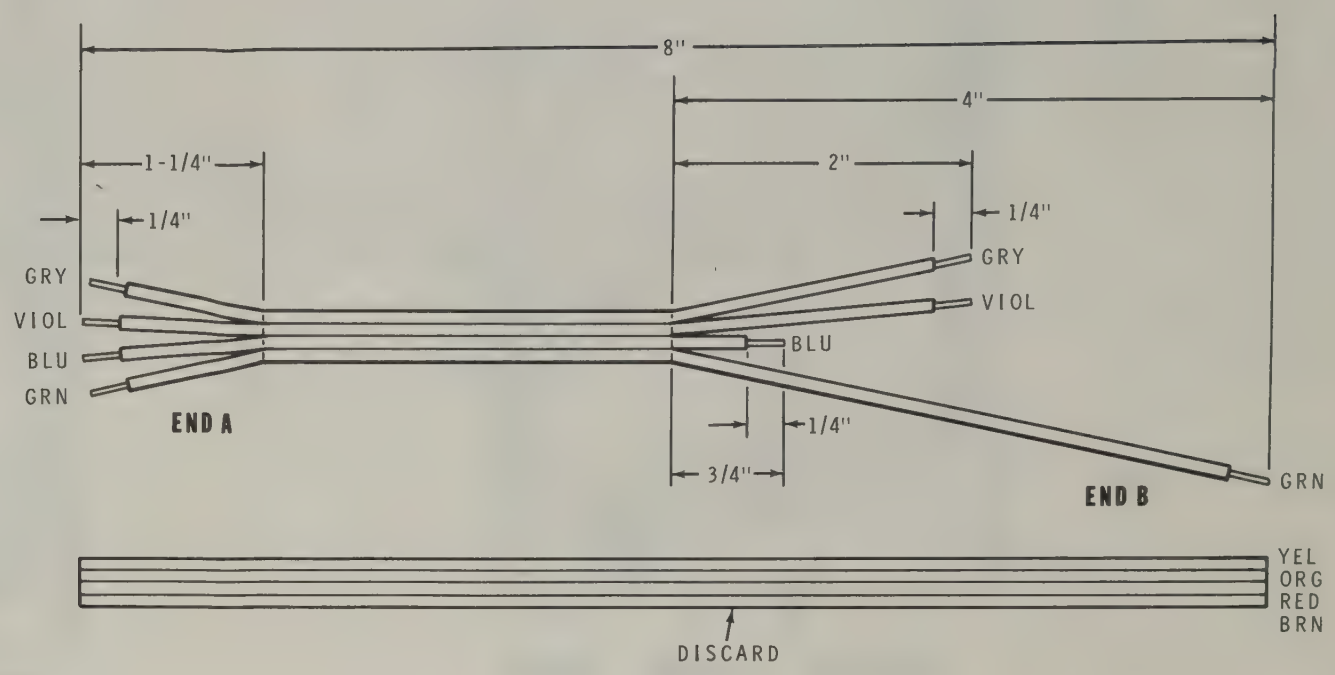
PICTORIAL 4-2



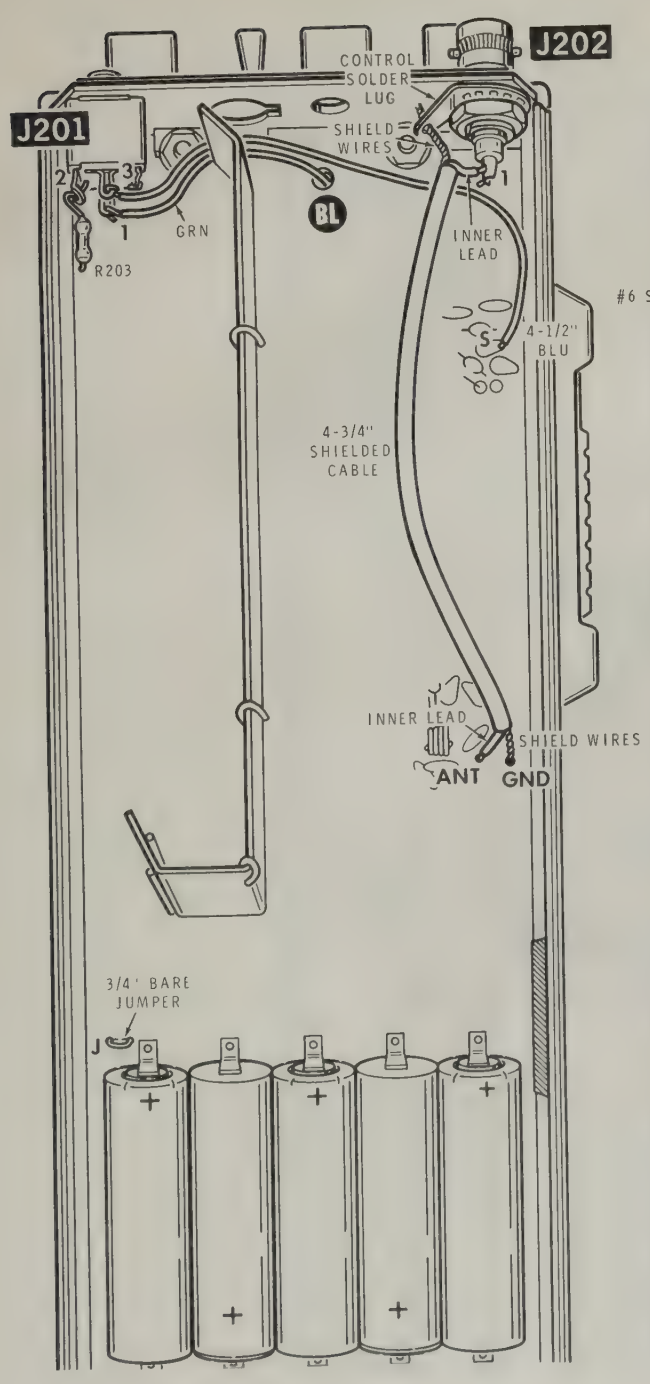
PICTORIAL 4-3



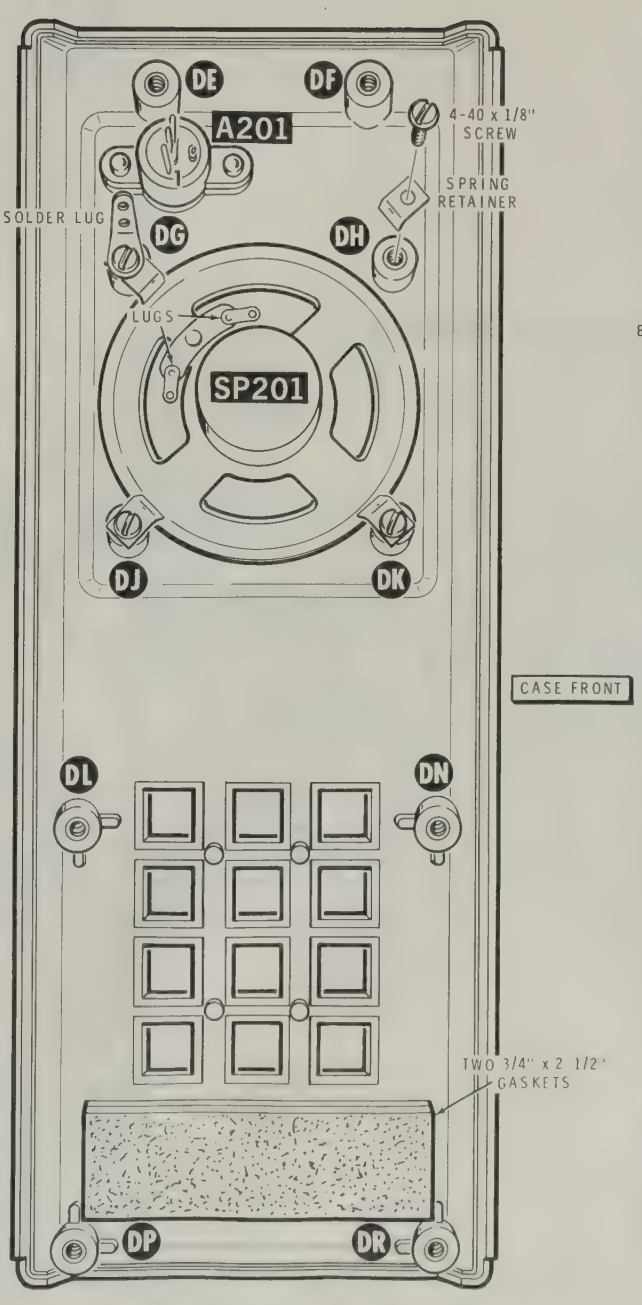
PICTORIAL 4-4



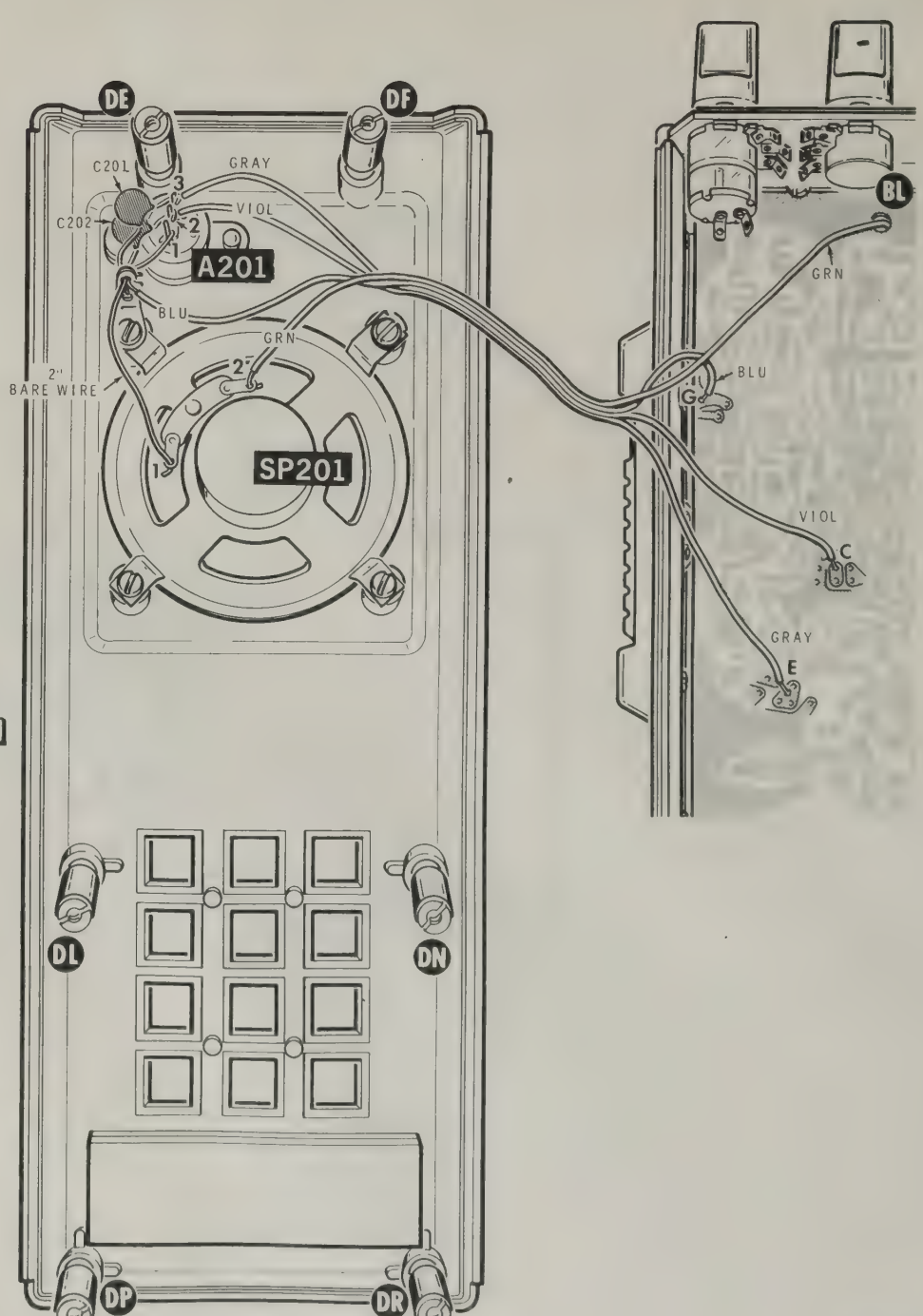
Detail 4-4C



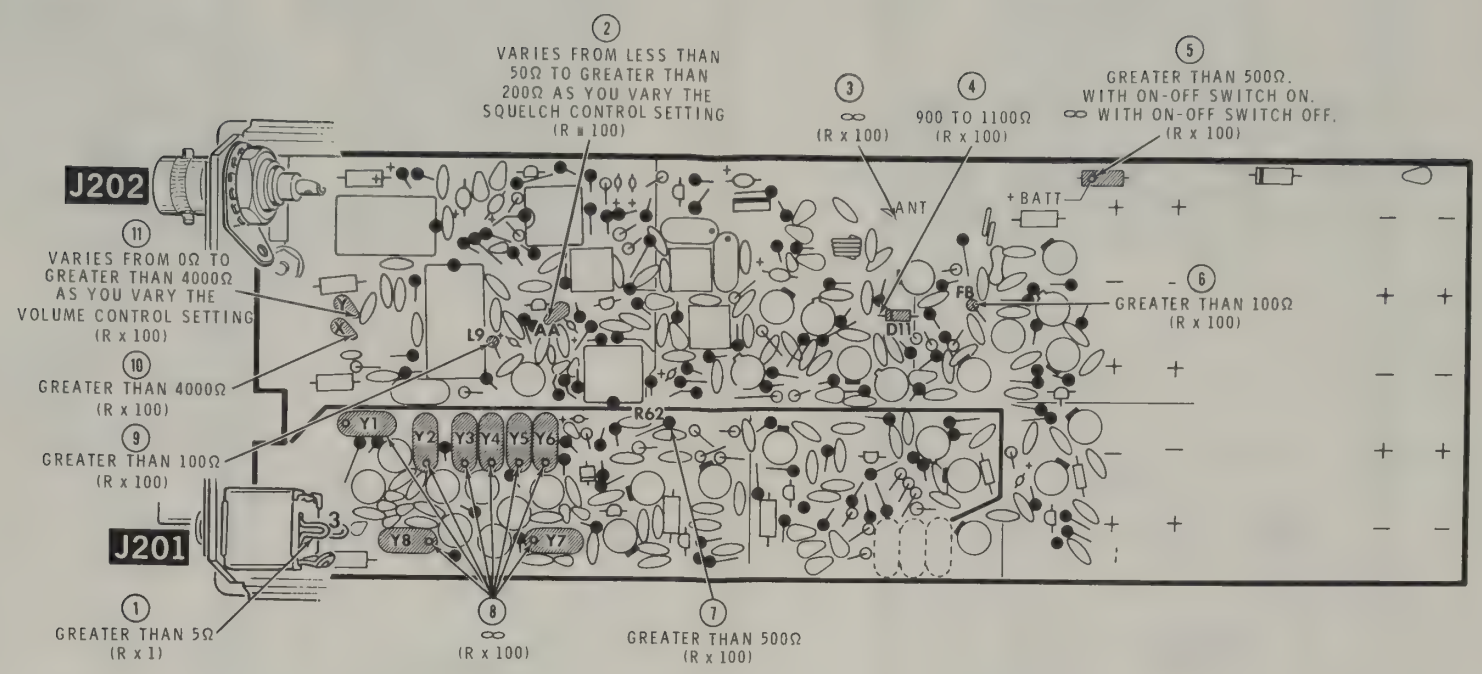
PICTORIAL 4-5



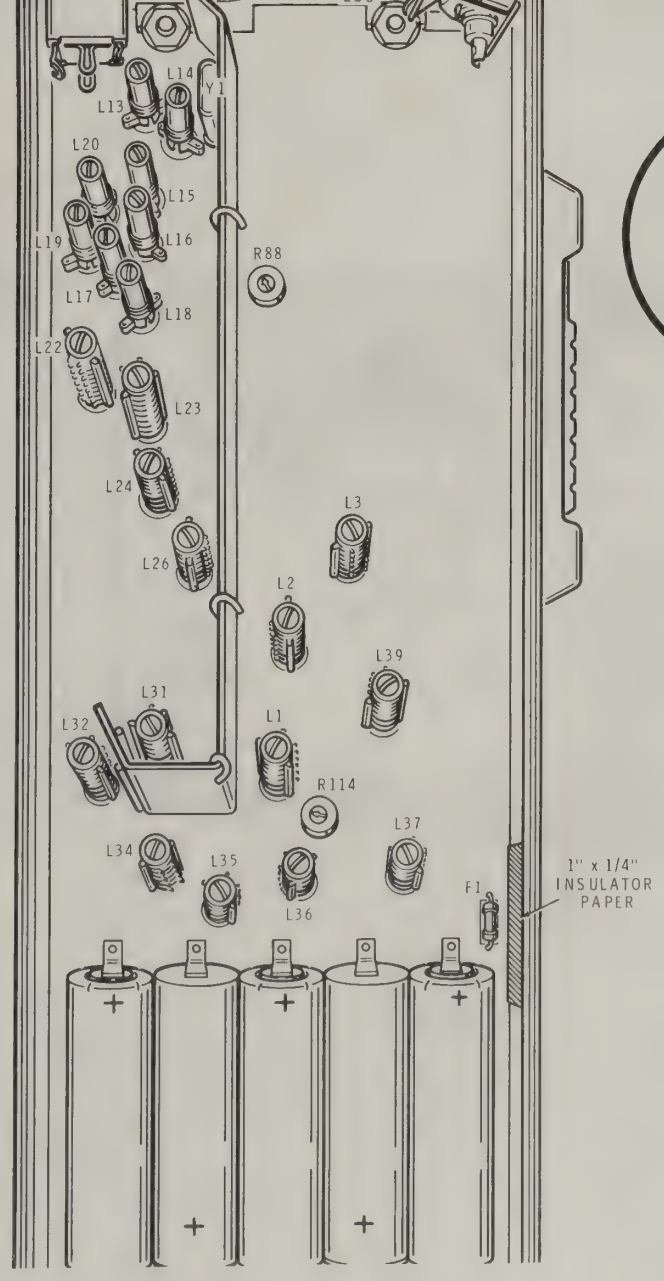
PICTORIAL 4-6



PICTORIAL 4-7

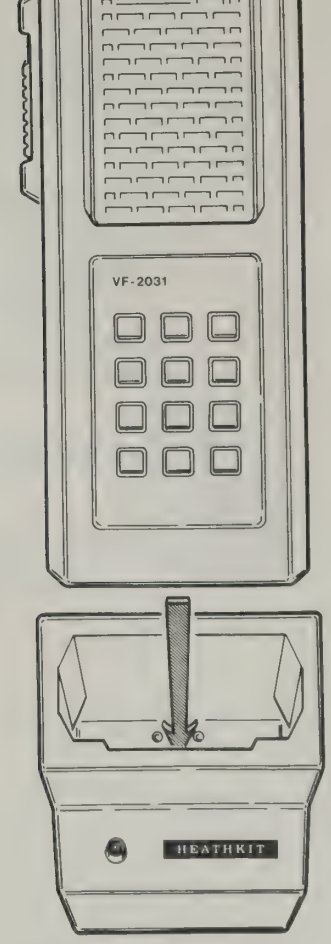


PICTORIAL 5-1

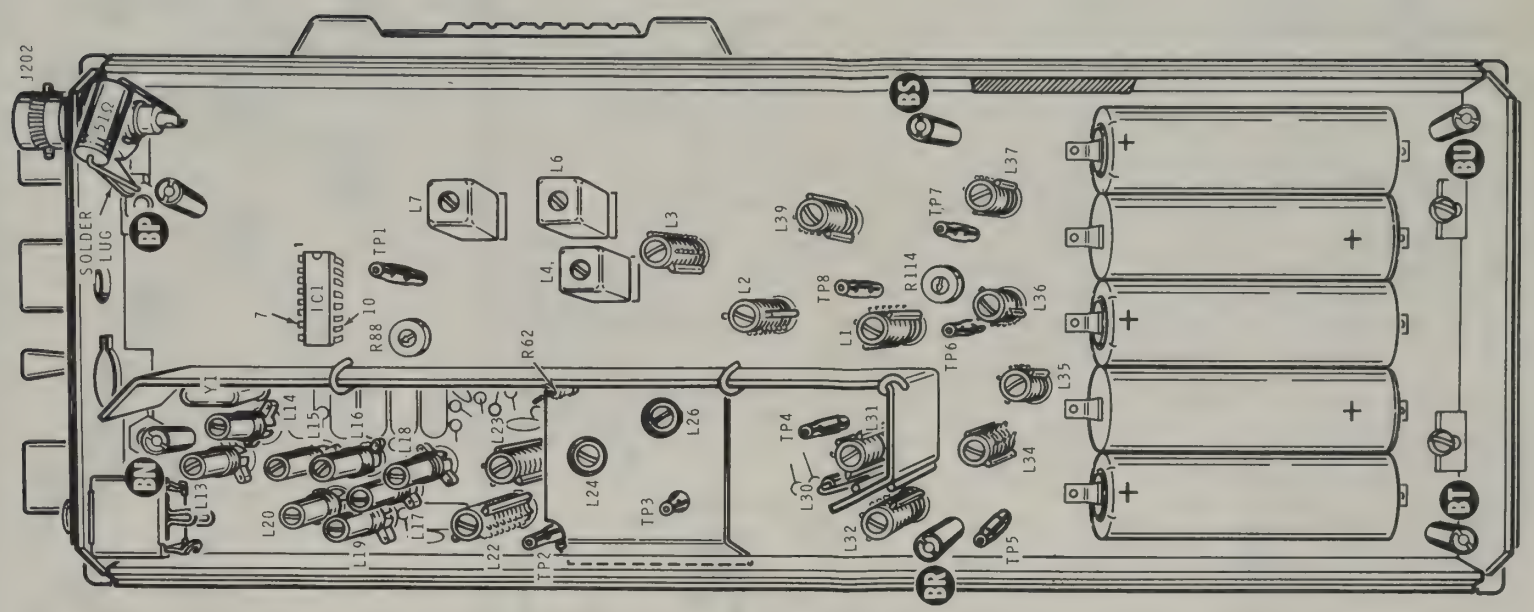


PICTORIAL 6-2

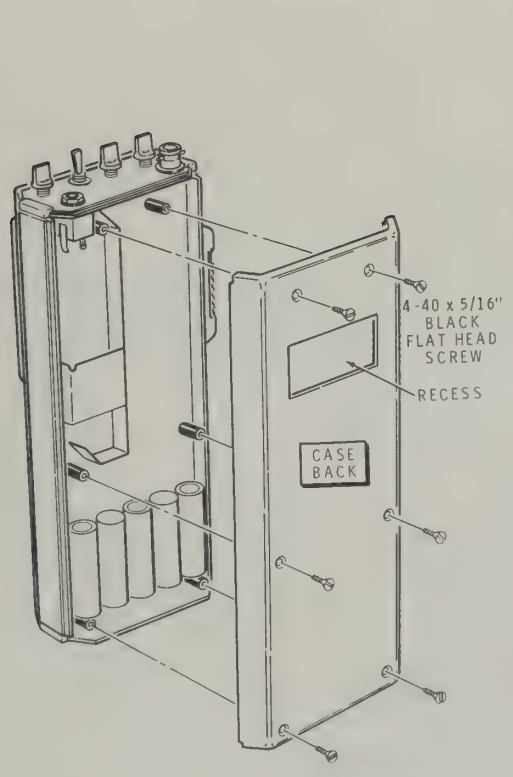




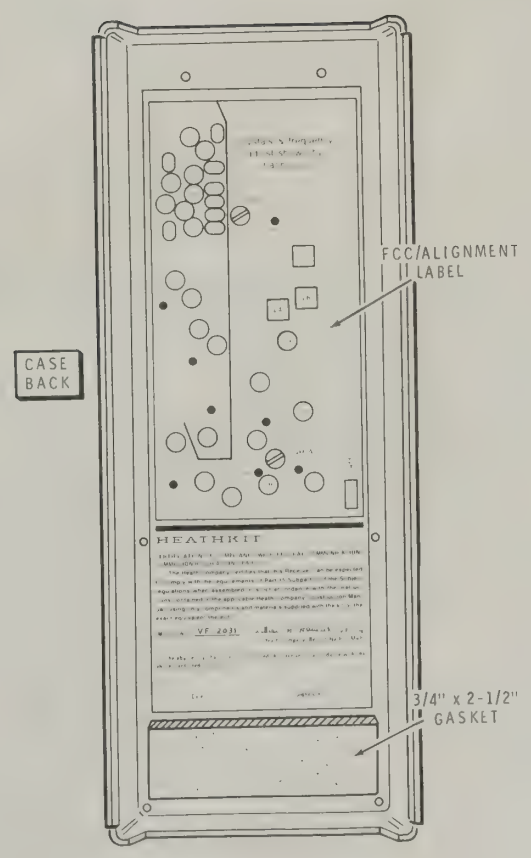
PICTORIAL 6-3



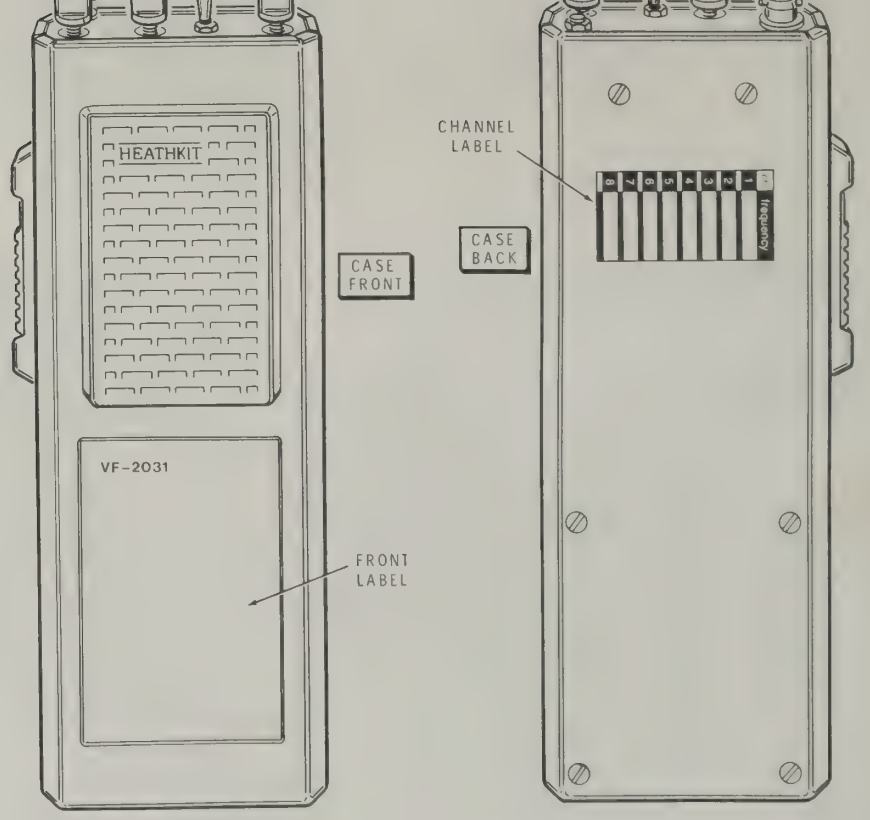
PICTORIAL 6-4



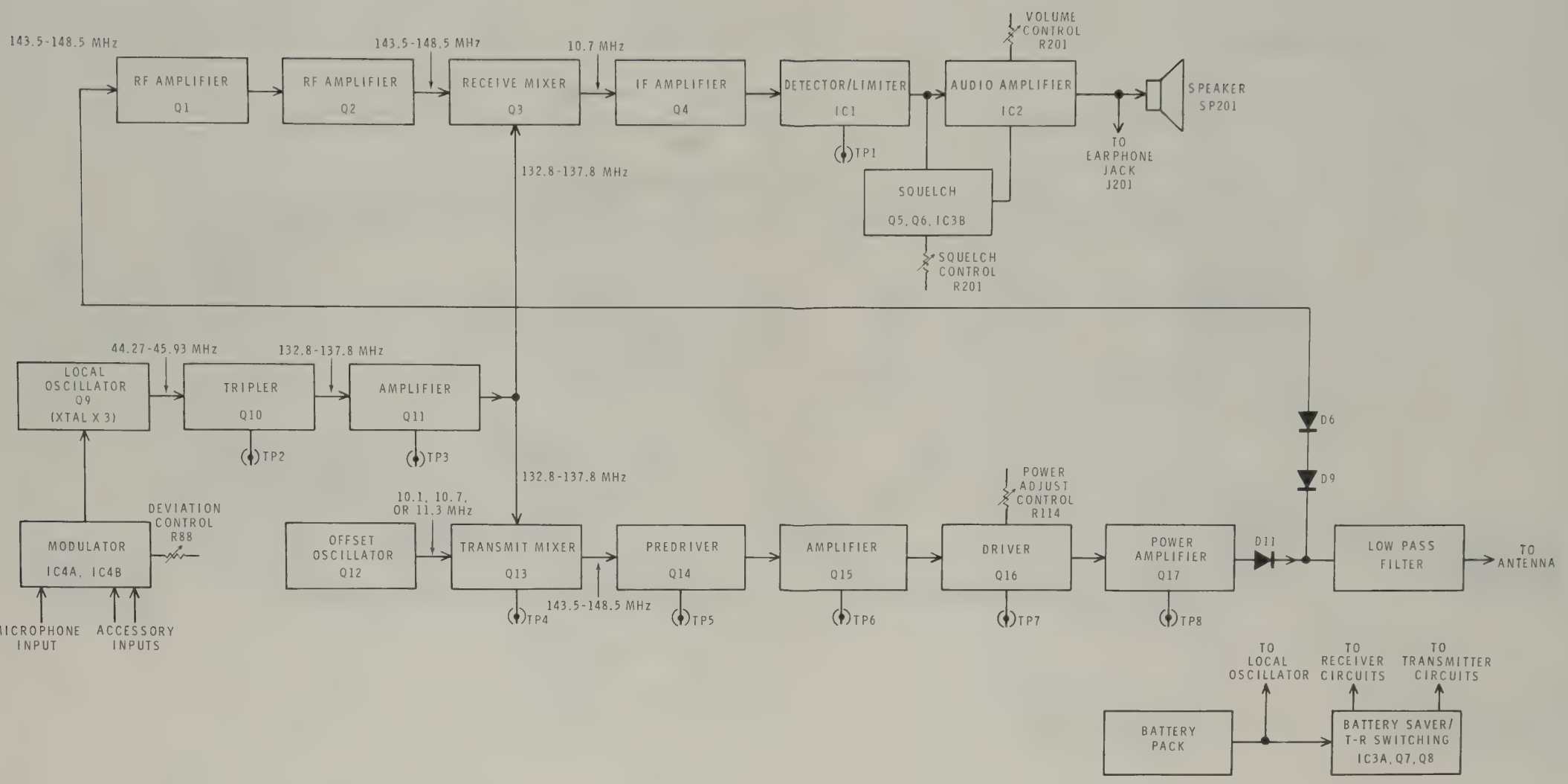
PICTORIAL 7-1



Detail 7-1A



PICTORIAL 7-2



BLOCK DIAGRAM

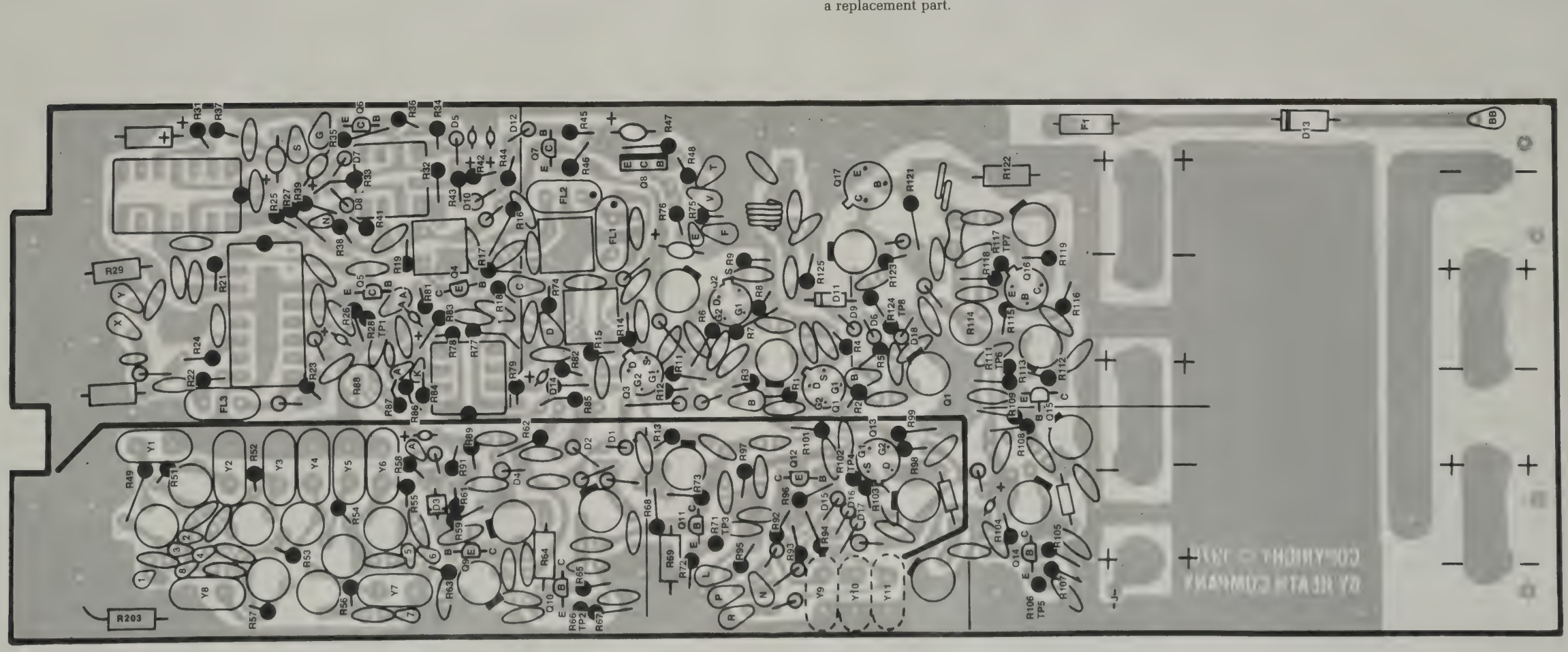
CIRCUIT BOARD X-RAY VIEWS

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on one of the"X-ray Views".

B. Locate this same number in the "Circuit component Number" column of the "Parts List."

C. Adjacent to the circuit component number, you will find the PART NUMBER and the DESCRIPTION, which must be supplied when you order a replacement part.

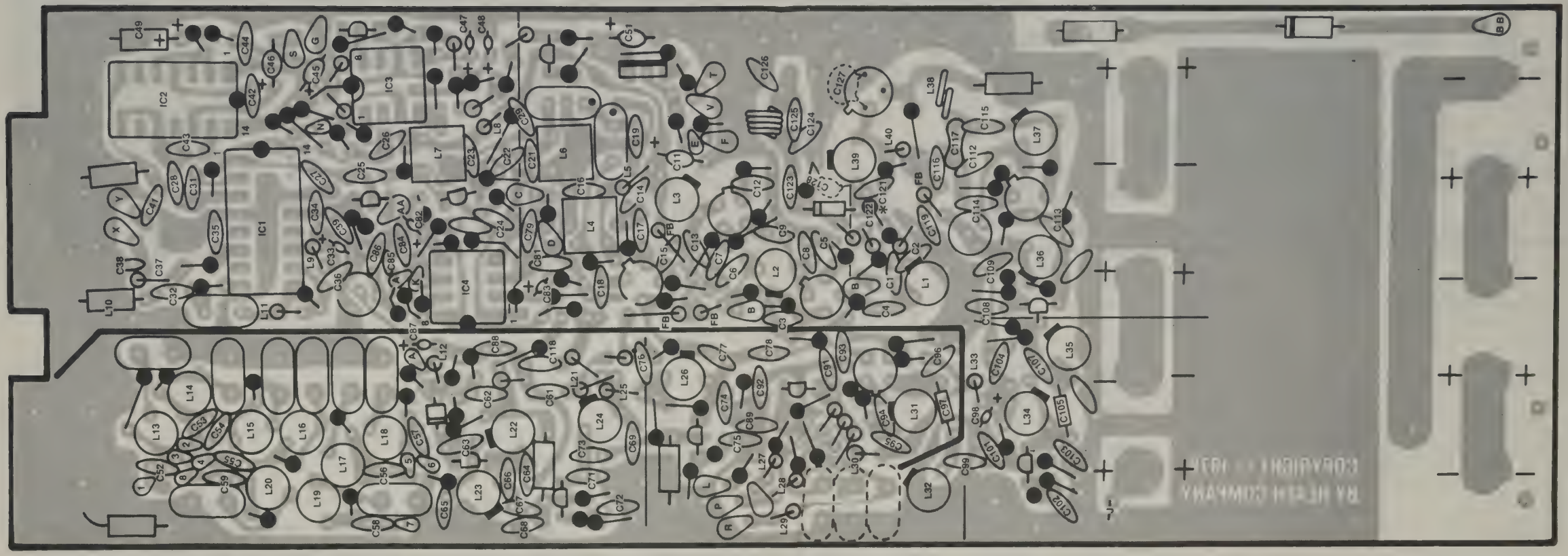


(Shown from component side.)



(shown from foil side)

*C121 is not used.
Dashed-in components are on foil side of circuit board.

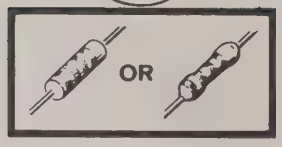


(Shown from component side)

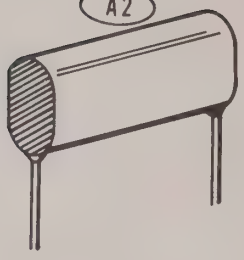
ILLUSTRATIO

BATTERY CHARGER

A1



A2



A3



B1



B2



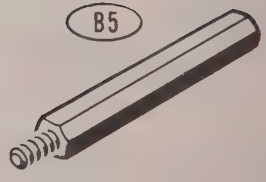
B3



B4



B5



C1



C2



C3



D1

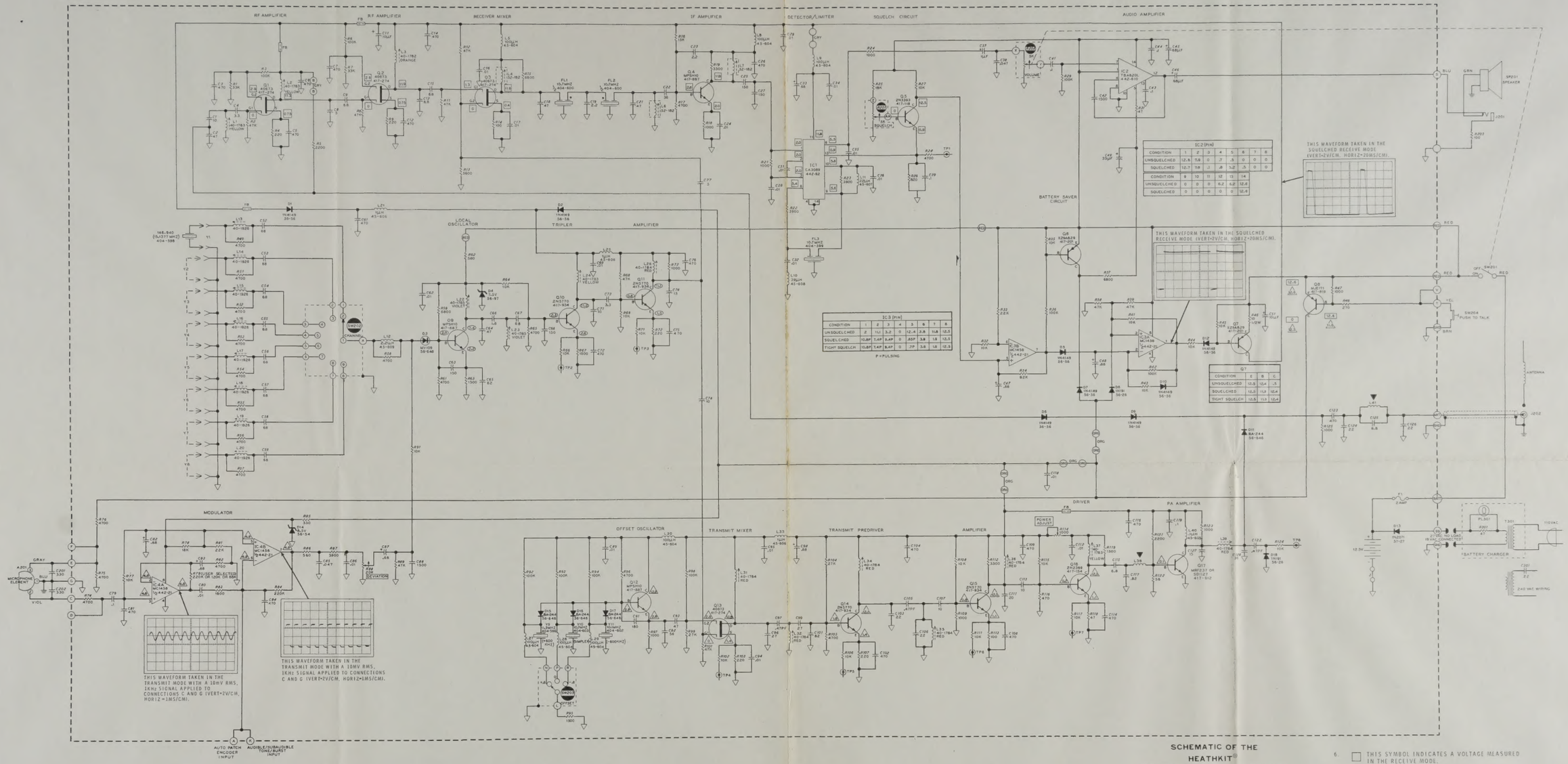


D2



D3





SCHEMATIC OF THE HEATHKIT® HAND-HELD 2-METER TRANSCEIVER MODEL VF-2031

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:

 1-199 PARTS ON THE CIRCUIT BOARD.
 201-299 PARTS ON THE CASE.
 301-399 PARTS IN THE CHARGER.

2. ALL RESISTORS ARE 1/4-WATT, 5% TOLERANCE, UNLESS OTHERWISE NOTED. RESISTOR VALUES ARE IN OHMS, k=1000, M=1,000,000.

3. CAPACITORS LESS THAN 1 ARE IN µF (MICROFARADS). ALL OTHER CAPACITORS ARE pF (PICOFARADS) UNLESS OTHERWISE NOTED.

4. ARROWS AT CONTROLS INDICATE CLOCKWISE ROTATION AS VIEWED FROM THE SHAFT END, OR TOP OF, THE CONTROL.

5. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASURED WITH A HIGH INPUT IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CASE GROUND. ALL VOLTAGES ARE ± 20%.

6. □ THIS SYMBOL INDICATES A VOLTAGE MEASURED IN THE RECEIVE MODE.

7. △ THIS SYMBOL INDICATES A VOLTAGE MEASURED IN THE TRANSMIT MODE.

8. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.

9. ⏦ THIS SYMBOL INDICATES CASE GROUND.

10. ◯ THIS SYMBOL INDICATES A SOLDERED CONNECTION TO THE CIRCUIT BOARD.

11. ▼ THIS SYMBOL INDICATES A COIL WOUND BY THE KITBUILDER.

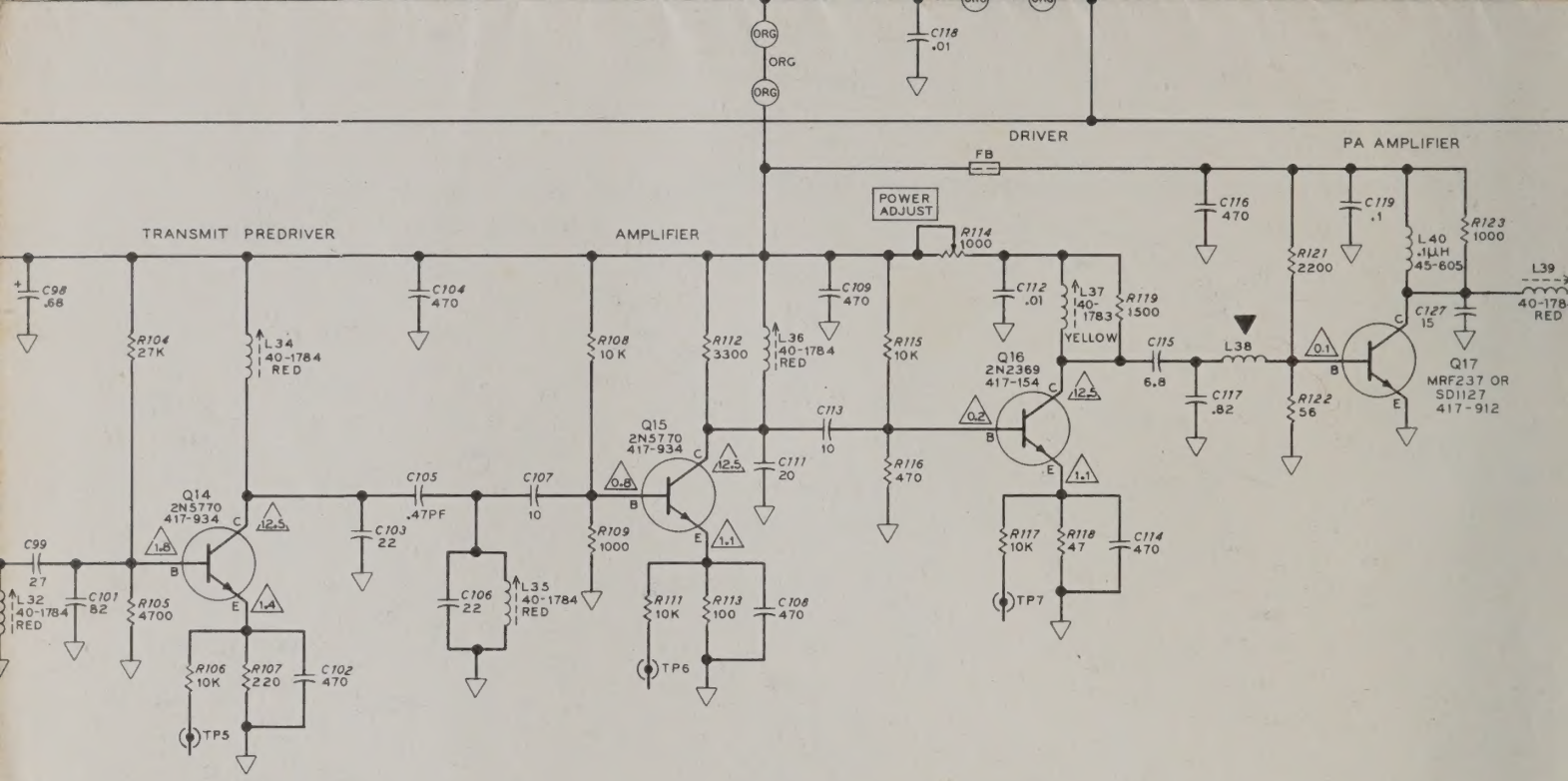
12. ⊕ THIS SYMBOL INDICATES A TEST POINT.

13. ⛀ THIS SYMBOL INDICATES A COMPONENT DRAWN WITHIN THE CIRCUIT BOARD OUTLINE THAT IS ACTUALLY MOUNTED ON THE CASE.

14. REFER TO THE CIRCUIT BOARD "X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.

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Part of 595-2085-02



SCHEMATIC O

HEATHKIT

HAND-HELD 2-METER

MODEL VF-20

NOTES:

1. COMPONENT NUMBERS ARE IN THE

 1-199 PARTS ON THE CIRCUIT
 201-299 PARTS ON THE CASE.
 301-399 PARTS IN THE CHARGER.

2. ALL RESISTORS ARE 1/4-WATT, 5%
 OTHERWISE NOTED. RESISTOR VA

3. CAPACITORS LESS THAN 1 ARE IN
 OTHER CAPACITORS ARE pF (PICO
 OTHERWISE NOTED.

4. ARROWS AT CONTROLS INDICATE
 AS VIEWED FROM THE SHAFT END,

5. ⬭ THIS SYMBOL INDICATES A
 MEASURED WITH A HIGH IN
 METER FROM THE POINT IN
 ALL VOLTAGES ARE ± 20%.

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

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THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

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